ELECTRICAL ENGINEERING

AUGUST 1961
Vol. 80, No. 8

THE COVER: One of the decouplers for isolating the three lines for radio-influence measurements at extra-high-voltage test line, Apple Grove, W. Va. At left is housing for corona-loss wattmeter, heating transformer, and series capacitor to maximize heating current. The two black "spools" are the chokes for the decoupler. Linemen are preparing to connect the lead from the coupling capacitor between the two chokes. Story on page 579.

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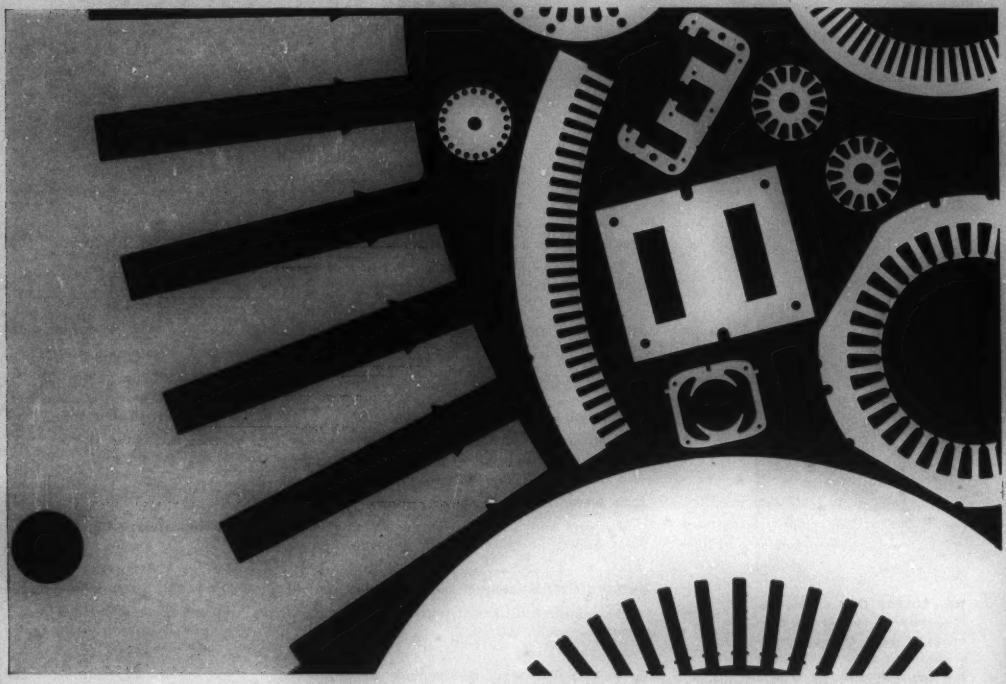

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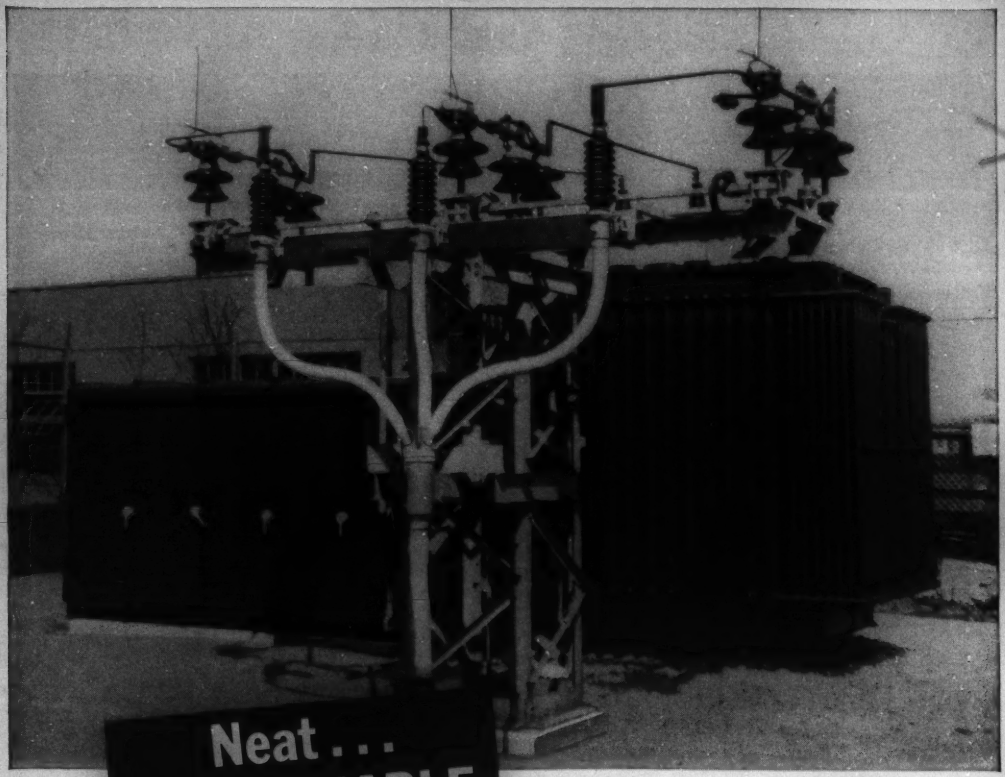
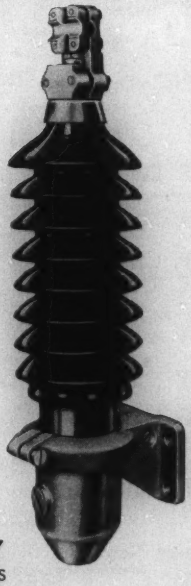


Neat . . . and RELIABLE

This industrial transformer load-center was installed in minimum time, requires little space, and presents an exceptionally neat appearance, largely because circuits were brought in underground and there are no overhead wires and few structures.

Standard G&W "ST-Sodertite" Potheads were used to terminate the 34.5-kv primary supply to this transformer station for long-time reliability. Type "ST" Potheads are permanently sealed at the factory by metal-to-porcelain soldered joints thus reducing the number of field operations necessary to seal the pothead against weather. Semi-conducting glaze on the porcelain between bottom petticoat and wiping sleeve controls longitudinal dielectric stresses of the cable termination. Extra internal creepage distance provided by closed hood and simple ferrule design further enhance reliability. Spun copper wiping sleeve and hood eliminate possibility of porosity, assuring maximum protection.

Get all the facts about standard G&W "ST-Sodertite" Potheads from your G&W representative or by writing for Bulletin AA56.



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1960 FIRST short-circuit withstand of 40 times Vari-Amp current

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1958 FIRST with Caliband control

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1939 FIRST unit construction

1938 FIRST unidirectional breather

1935 FIRST voltage integrating time delay

1933 FIRST 5/8% step regulator

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Fast, accurate control settings—assured by exclusive *Caliband* control.

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Positive series winding protection, by externally mounted regulator by-pass arresters.

These are only a few of a number of benefits you get with Allis-Chalmers SFR feeder voltage regulators. For all the facts — call, wire or write your nearby **Allis-Chalmers** office.

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New and Improved Products . . .

Radiation Detector . . .

Weighing less than 2 pounds, this new electromagnetic radiation detector was designed for hand-carrying or as a stationary instrument. Model *B86B1* operates over a frequency range of 400

to 10,000 mc and contains a single-integral antenna, while utilizing standard, large-capacity mercury batteries. The instrument responds to all planes of polarization—linear, left- and right-hand circular, random, pulsed and continuous wave. *Sperry Microwave Electronics Co., Clearwater, Fla.*

New Disconnect . . .

Only two segments and no loose pieces that can come apart are the twin features of this new compression disconnect for hot-line tool work. The U-bolt is rigidly attached and has peened ends to retain the nuts. Self-keying, the disconnect lug spots in position when its recess meets a boss on the tee's tongue. With indents on both sides, the lug can be engaged right or left. *Penn-Union Electric Corp., Erie, Pa.*

A-C/D-C Unit . . .

Suitable for atmospheric conditions prevalent at shipyards, this transformer-rectifier unit features hermetically sealed, oil-immersed silicon diodes for cathodic protection. With a 220/440-volt 3-phase 60-cycle input, maximum output is 75 amperes d-c in each of three circuits, or a total of 225 amperes at zero to 12 volts d-c adjustable in four steps. *Marcus Transformer Company, Inc., Rahway, N. J.*

Thermoelectric Generator . . .

Designed for long-term reliability, these 8-watt generators which operate on natural, propane, or butane gas, require no housing or special enclosure since the burner is completely free from wind blowout. Initial power applications will be for power transmission line valves and cathodic protection of buried or submerged metal. The new generators weigh 65 pounds and are 12 inches wide by 17 inches high. *Texas Instruments, Inc., P. O. Box 6027, Houston 5, Texas.*

New Insulation Material . . .

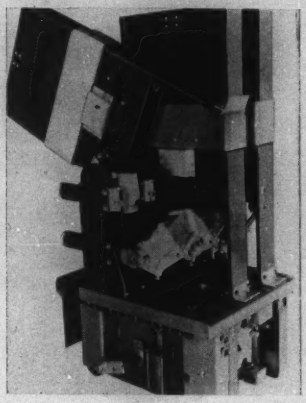
A new high-temperature electrical insulation based on a polymer experimentally known as ML offers a unique combination of properties for wire-insulating enamels, coated fabric space insulations, and insulating varnishes. Among its outstanding features are a life expectancy of more than 10 years at 200 C, more than 2 years at 250 C, and several months at 300 C. The material also possesses unusual solvent, moisture, radiation, and fire-resistance qualities. *E. I. du Pont de Nemours & Co., Wilmington, Del.*

Portable Load Center . . .

Here is a lightweight, self-contained 120/240-volt a-c 50-ampere portable utility distribution center that weighs only 30 pounds and can be set up by one man at the construction site in a matter of minutes. Designed for temporary power requirements, the compact load center with overload and short-circuit protection contains six 15-ampere 120-volt outlets for power tools and one 20-ampere 2-pole 240-volt outlet for welding or similar uses. The centers can be cascaded by means of heavy-duty 4-wire receptacles located on either end of the main bus. *Leonard Electric Mfg. Co., 3907 Perkins Ave., Cleveland 14, Ohio.*

New Switchgear . . .

Production is scheduled to begin immediately with availability early this fall for these newly designed 5 and 15 kv metal-clad switchgear assemblies. Some design "firsts" will be: (1) longer



contact life by means of increased contact pressure induced by a unique blow-on force on both main and arcing contacts; (2) innercooling by use of a hollow primary conductor with an orifice cut in the top to allow continuous air circulation; (3) compound, face-wound blowout coils; and (4) mechanically stronger interrupter assembly achieved by stacking zircon arc chute barriers in their uncured state, then curing and fusing in one process. *Moloney Electric Co., St. Louis 20, Mo.*

Medical Transmitter . . .

This new instrument permits simultaneous remote monitoring of three biolectrical signals by telemetry. Self-contained, and about the size of a box of kitchen matches, Multi-pack amplifies, multiplexes and transmits signals over a standard FM frequency band; maximum transmission distance is 100 yards. A *B-30D* discriminator restores the signals to proper form for recording or display. One channel has operating characteristics suitable for galvanic skin response signals. The others are for slower-varying signals such as temperatures, respiration and blood pressure. *Litton Industries, Inc., 336 North Foothill Rd., Beverly Hills, Calif.*

(Continued on page 13A)

(Continued from page 8A)

Integrated Data-Phones . . .

Introduction of the *202A* to replace series *200* marks the first of three units that will be available for data transmission in standardized housings. This uniformity will aid business equipment

manufacturers to design machines compatible in appearance and function, and will provide a family appearance to the Bell System's growing line of sets. The two other units will differ only in size. The *202A* has a transmission speed capacity of 1,600 words per minute or 1,200 bits per second. *Bell Telephone Laboratories, 463 West St., New York, N. Y.*

Pneumatic D-C Recorder . . .

This apparatus measures direct current and then transmits the data pneumatically to a central receiver. Recommended for high-amperage applications found in electrolytic refining, plating, aluminum reduction, and sodium chloride electrolysis, the system senses at a calculated distance the magnetic field established by a flow of direct current through a bus bar. The magnetic lines of force around the conductor deflect a flexure-pivoted rod-shaped magnet. The torque of this deflection, which is related to the intensity of the magnetic field and therefore current flow, operates a flapper-nozzle detector in a pneumatic force-balance system. *The Foxboro Co., Foxboro, Mass.*

Straight-Line Brush Terminals . . .

In the original assembly, these quick disconnect terminals were designed with a 90-degree bend. Now a straight-line clip is also available. Redesign of the clip provides an improved, more positive-acting steel spring for maximum stability. In addition, two spade terminals may be inserted in one clip. Capable of carrying a continuous current of 150 amperes, the assemblies permit brush changes while the machine is running without the hazard of having tools or terminal screws drop in the commutator. *National Carbon Co., 270 Park Ave., New York 16, N. Y.*

High-Temperature Cables . . .

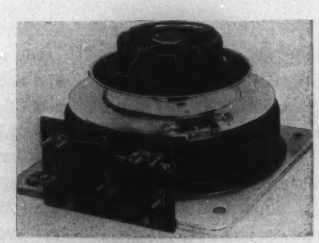
Designed for hot-spot problems, these cables use a special butyl wire insulation and jacket for the portable line and butyl insulation with an asbestos braided jacket for the stationary line. Field tested in difficult applications such as steel mill soaking pits, annealing oven, and cement kilns, the Securityflex cables have an indicated rating of 125 C with a service life of two to three times that of standard portable cables used in high-temperature work. *Anaconda Wire & Cable Co., Hastings-on-Hudson, N. Y.*

Dynaquad . . .

Because of its bistable nature, this first alloyed junction 4 layer device can replace a number of transistors and components, resulting in a considerable reduction in circuit complexity and component requirements. For simple on-off switching it behaves as a pulse operated latching relay with no bounce, chatter, or sticking contacts. Basically a germanium 3-terminal p-n-p-n structure, it is a 2-position switch with a switching capacity in the megacycle range usually associated with digital computers. Rise time is 0.1 microsecond with an output swing of 35 volts. *Tung-Sol Electric, Inc., 100 Eighth Ave., Newark 4, N. J.*

30-Ampere Autotransformer . . .

Series *W* Variac line has been expanded to include 30-ampere units in single, 2-, or 3-gang combinations. Providing smooth, continuous, manual control of a-c voltages from zero to 17% above input-line voltage, type *W 30* can be used for testing and development work, for variable lighting



applications, temperature regulation, motor speed control or calibration, and for adjustment of voltage in power supplies and aging racks. A high-silicon low-loss material is used for the transformer core. All models can be readily adapted to motor-driven assemblies. *General Radio Company, West Concord, Mass.*

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Up to 1500 Amperes

Over 200
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Automatic Battery Chargers
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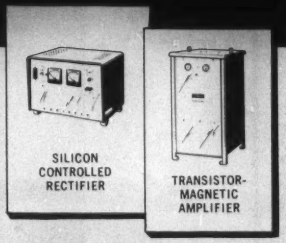

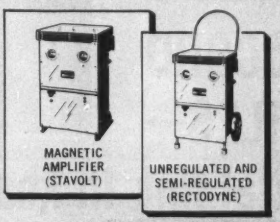

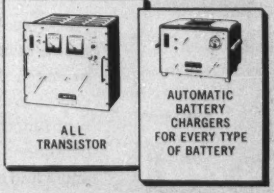

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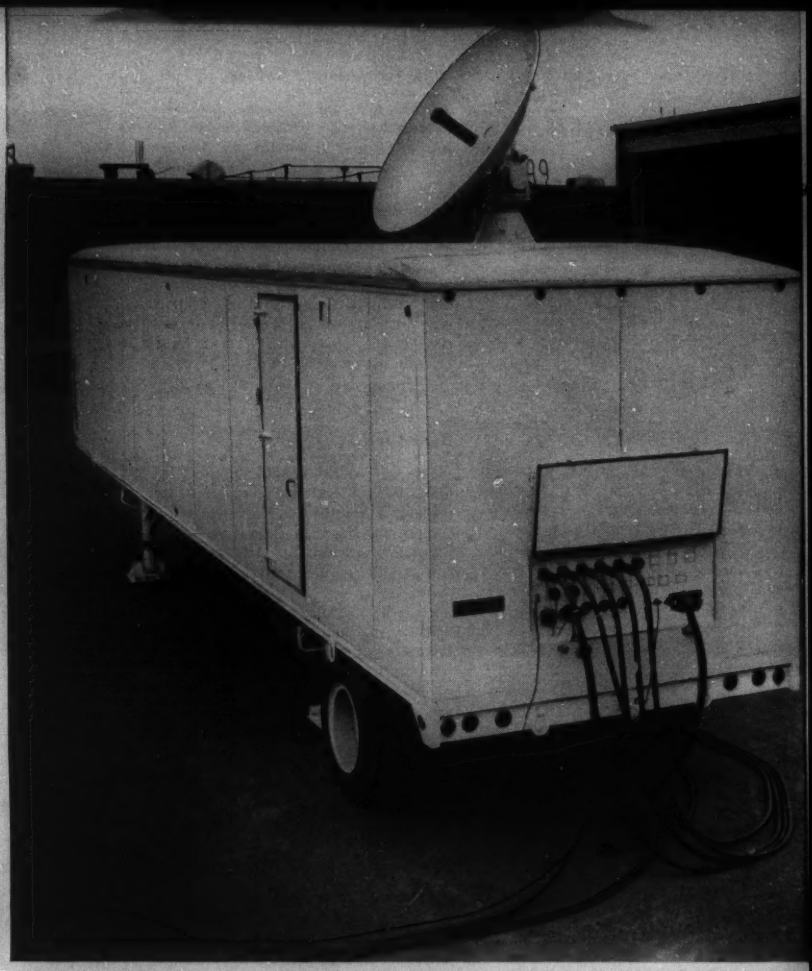
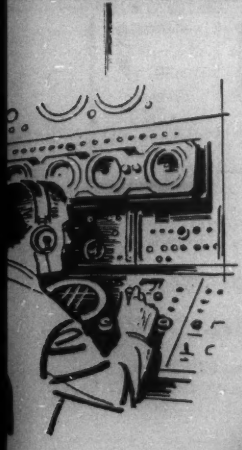


OKOCORD CABLES—

A vital link in keeping an eye on the man in space



For Project Mercury's man in space assignment, radar keeps its electronic eye on the progress of the orbital flight and Okocord cables are playing a key role in this important function. Where dependability under all conditions is essential, it is more than likely you'll find an Okonite product is the **vital link.**

EXAMPLE: Tough, super-flexible Okocord cables serve as a power link between radar units housed in 35-foot trailers and separate radar antennas in equipment manufactured by the Reeves Instrument Corporation. A part of Project Mercury's Very Long Range Radar Tracking System, the unit shown here, is one of a number that will pinpoint the position of the first American to orbit the earth from blast-off to pickup.

Why were Okocord cables chosen for this vital assignment? Because power failure is out of the question and Okocord cables have earned their reputation for delivering under conditions ranging from normal to the abnormal. Like all Okonite cables, they're the result of Cable'bility—80 years of cable craftsmanship.

If you use portable cables for mobile equipment, apparatus, power tools and appliances, there is an Okocord cable designed for your specific needs. For full details . . . write for bulletin EG-1108—The Okonite Company, Subsidiary of Kennecott Copper Corporation, 220 Passaic Street, Passaic, New Jersey.

where there's electrical power . . . there's **OKONITE CABLE**

8220

Business Trends...

EXPENDITURES by American business concerns on communications will increase from an estimated $4½ billion in 1960 to more than $10 billion annually before 1970, according to D. C. Power, chairman of General Telephone & Electronics Corp. Because of industry's steadily expanding use of data-processing systems, telephone facilities within the next few years will be carrying more data and image transmission than voice communications.

• • •

WESTINGHOUSE Electric International Co. and Le Materiel Electrique S-W of Paris announce that they will supply about $8 million worth of electrical equipment to Union Siderurgique du Nord de la France, S.A., to power the steel mill Usinor is building at Dunkirk, France. The two companies will provide 12 main drive motors totaling 93,000 hp, main drive and auxiliary controls, 325 d-c table motors, switchgear, etc.

• • •

THE U. S. NAVY Bureau of Ships has awarded the Polarad Electronics Corp., Long Island City, N. Y., a $383,080 contract to furnish 66 wide-dispersion single-unit spectrum analyzers and auxiliary equipment. The analyzers are used for measurement and observation of spectral characteristics of wide or narrow pulses, FM characteristics, and r-f signals with wide frequency separation.

• • •

GENERAL Dynamics/Astronautics has received a $2.5 million contract to build three Atlas missile procedure trainers for the U. S. Air Force. The equipment will be used to teach launch procedures to crews. The first of the trainers will be delivered later this year.

• • •

AN ION-EMISSION microscope so powerful it can magnify the head of a pin to cover a 250-mile area or can be used to study a mass made up of only nine atoms, is used at the U. S. Steel Company's research laboratory at Monroeville, Pa. The magnification is said to be 2 million times.

• • •

SALES of phonographs, television and radio receivers, and television picture tubes fell off in April, according to the Electronic Industries Association. The figures show the continuing up-and-down pattern which has characterized the first 4 months of this year.

SILVER is an essential contact material in almost every kind of an electric and electronic appliance and in silver-zinc and silver-cadmium batteries. While this metal is available at 91 cents per ounce from the U. S. Treasury, there is a distinct possibility that a silver shortage will occur within a year or so, according to the American Smelting and Refining Co. Silver mining is almost nonexistent today; nearly all free world production is a by-product of lead, zinc, copper, and gold mining. High production costs make silver mining, as such, a nonpaying undertaking.

• • •

MANAGER of marketing research for General Electric's advanced product planning operation, A. E. Kimball, predicts a sharp increase in the use of semiconductors in consumer appliances and industrial applications. Bargain prices for semiconductors will make possible a rapid spread of their use in the next 2 years.

• • •

TWO 85-foot radio antennas at the Jet Propulsion Laboratory Goldstone tracking station in the Mohave Desert, Calif., were used to transmit experimental signals to and pick up echoes from Venus. The round trip took about 6½ minutes. Scientists hope to ascertain if the planet spins on its axis and if so, what is its orientation, and the rotational speed.

• • •

THE Washington Public Power Supply System has filed with the Federal Power Commission new designs for the Nez Perce Project which will lower the total construction cost from $348.5 million to $297 million, a saving of $51.5 million.

• • •

THE Geysers Power Plant (opened in June 1960), the first geothermal steam plant in the country, operates automatically without attendants, and requires no boilers. According to D. A. McMillan, president of Thermal Power Co., San Francisco, the company made a record output in one month of 8,658,000 kw-hr.

• • •

CONTRACTS totaling $900,000 for manufacturing "umbilical" electrical connectors used in the launching tube system of Polaris missiles were awarded to the Scintilla division of the Bendix Corp. The umbilical connectors will be used in the electric system connecting the master missile control center in a submarine to the launching mechanism inside the tubes.

Should I Become a Registered Professional Engineer?

E. R. WHITEHEAD
FELLOW AIEE

The affirmative answer to the question posed in the title is underscored by cogent arguments drawn from the author's 10 years of experience as a member of a state board of engineering examiners. A country-wide listing of state boards of engineering examiners is appended to the article.

THE title of this article poses the question asked of the author countless times over a period of 10 years during which he has been a member of the AIEE Registration of Engineers Committee and a member of a state board of engineering examiners. It seems appropriate, therefore, to draw on this experience both in outlining the circumstances which raise the question and in seeking an answer.

The Engineers Council for Professional Development (ECPD) has approved the following definition of engineering for trial use:

> Engineering is the profession in which a knowledge of mathematics and the natural sciences, gained by study, experiment, and practice, is applied with judgment to develop ways to utilize economically the materials and forces of nature for the progressive well-being of mankind.

While many more succinct definitions are available, most of them fall far short in furnishing criteria which are essential for legal use. Our definition suggests the legal basis for registration laws in its reference to the well-being of mankind and supplies a clear statement of the kind of activity which affects this welfare. Thus, the police power of the state is invoked to protect the life, health, and property of its citizens against those incompetent to practice the profession.

FUNDAMENTAL OBJECTIVE

It is easy to lose sight of the fundamental objective of registration laws and to stress their role in elevating the status of members of the profession. Such laws are not enacted to establish and protect a privileged class of citizens. It is equally clear, however, that the attainment of true competence as an engineer reflects not only the "study, experiment, and practice" described in our definition, but also a continuing effort to maintain and develop this competence. Laws which establish a minimum level of professional competence by insuring adequate training and experience thus serve to protect both the public and the engineer against misrepresentation and malpractice.

PATTERN OF REPLIES

FOR A NUMBER OF YEARS, one of the standard questions asked by the author of applicants during the required personal interview has been, "Why do you wish to become registered as a professional engineer?" The replies have fallen into the following pattern:

1. My work is directly covered by the professional engineering act and I must do so to practice legally.
2. My work for my company is exempt but my company urges registration as a means of attesting to professional competence.
3. Although my work is exempt now, there is no reason to expect that this will always be the case, and I wish to be prepared for any opportunity which may require registration.
4. I plan to engage in consulting practice in the future and will need a license.
5. I believe in registration as a means of advancing our profession.

Although the applicants offering answer No. 1 were acting in response to increased understanding of the purpose of the law, there is a pronounced trend toward more efficient enforcement and little need be added regarding this reason for registration.

In increasing numbers, companies employing large numbers of engineers are encouraging those who hold, or are candidates for, positions of responsibility to become registered, so that replies in category No. 2 are becoming more frequent.

Reply No. 3 is closely related to No. 2 but the motivation is primarily personal. Frequently this reply is modified to indicate that the applicant simply wishes to support registration as a means of contributing to the development of the profession.

Reply No. 4 is very generally given by engineers approaching retirement age in an exempt classification but who feel qualified and able to continue their professional activity on a personal basis. Too frequently, however, the realization of the legal requirement of

A special article recommended for publication by the AIEE Registration of Engineers Committee.

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registration, usually by written examination, comes as a disagreeable surprise.

Reply No. 5 is frequently combined wtih one of the others.

Although some states register by broad branches of engineering, it seems evident that the number of areas of specialization, as indicated by technical organizations and functional groups, is growing so rapidly that adequate certification of specialized competence is becoming increasingly impractical. On the other hand, the opposite trend in engineering education lends encouragement to the view that minimum standards of knowledge in the basic and engineering sciences can be adequately enforced, and that minimum experience in their application to engineering practice can be adequately investigated. It is clear that at some point professional ethics will require supplementary evidence of competence when highly specialized work is to be undertaken for the public. Although it is recognized that most electrical engineers practice their profession within the corporate form of business organization, the increasing complexity of new engineering systems may well see an acceleration of the trend toward engineer-scientist teams in both product-oriented and service-oriented organizations. It is the author's hope that the trend in registration procedure can be directed toward the assurance of broad competence at an acceptable minimum professional level, and that the technical societies can and will serve the exceedingly important function of adding their certification in specialized fields.

CONCLUSION

In concluding this brief article the author would like to suggest the following answers to its title: Yes, you should become a registered professional engineer because:

1. You may be specifically required to be registered under the law.
2. Your employer may value your attainment of legal professional stature even though his activity is exempt under the law.
3. You may at any time be offered an opportunity which makes registration desirable or even essential.
4. Circumstances may permit part-time or full-time consulting practice for which registration is necessary.
5. It is easier to pass the necessary examinations in the early years of your career. Don't wait until you retire!
6. You will thereby enhance the stature of your profession by lending your support to those who have submitted their qualifications to evaluation for the benefit of all.

For application blanks and further information on requirements for registration, write your state board of engineering examiners.

Appendix

Alabama. State Board of Registration for Professional Engineers and Land Surveyors, C. C. Cobb, Executive Secretary, 64 N. Union St., Montgomery 4.

Alaska. Board of Engineers and Architects Examiners, R. V. Killewich, Secretary, Box 1416, Juneau.

Arizona. State Board of Technical Registration, Mrs. Rayma Neeb, Executive Secretary, Room 403, 128 N. First Ave., Phoenix.

Arkansas. State Board of Registration for Professional Engineers, B. A. Curry, Secretary, P. O. Box 1117, Park Hill Station, North Little Rock.

California. State Board of Registration for Civil and Professional Engineers, A. I. Flaherty, Executive Secretary, 529 Business and Professions Bldg., 1020 N. St., Sacramento 14.

Canal Zone. Board of Registration for Architects and Professional Engineers, G. A. Doyle, Jr., Secretary, P. O. Box 223, Balboa Heights.

Colorado. State Board of Registration for Professional Engineers, J. S. Findley, Assistant Secretary, Room 220, Majestic Bldg., Denver 2.

Connecticut. State Board of Registration for Professional Engineers and Land Surveyors, C. H. Coogan, Jr., Secretary, 30 Oak St., Hartford 6.

Delaware. State Board of Registration for Professional Engineers and Land Surveyors, F. T. Lynch, Secretary, 11 E. 12th St., Wilmington 1.

District of Columbia. Board of Registration for Professional Engineers, Mrs. L. W. Coad, Executive Secretary, 1740 Massachusetts Ave., N.W., Washington 6.

Florida. State Board of Engineer Examiners, Mrs. A. P. Clover, Executive Secretary, 408 John F. Seagle Bldg., Gainesville.

Georgia. State Board of Registration for Professional Engineers and Land Surveyors, C. L. Clifton, Joint Secretary, 224 State Capitol, Atlanta.

Hawaii. Board of Registration for Professional Engineers, Architects and Land Surveyors, W. C. Furer, Executive Secretary, 1909 Aleo Place, Honolulu 14.

Idaho. State Board of Engineering Examiners, O. C. Mayer, Secretary, Idaho Power Company Bldg., Boise.

Illinois. Professional Engineers' Examining Committee, F. B. Selke, Superintendent of Registration, Room 109, Capitol Bldg., Springfield.

Indiana. State Board of Registration for Professional Engineers and Land Surveyors, Ferdinand Jehle, Secretary, 145 W. Washington St., Room 502, Indianapolis 4.

Iowa. State Board of Engineering Examiners, W. G. Cunningham, Secretary, State House, Des Moines 19.

Kansas. State Board of Engineering Examiners, Mrs. Della Sterrett, Executive Secretary, 1159-W, State Office Bldg., Topeka.

Kentucky. State Board of Registration for Professional Engineers, C. S. Crouse, Secretary, 223 Mineral Industries Bldg., 120 Graham Ave., Lexington.

Louisiana. State Board of Registration for Professional Engineers and Land Surveyors, F. W. MacDonald, Executive Secretary, Tulane University Station, New Orleans 18.

Maine. State Board of Registration for Professional

Engineers, B. L. Hopkins, Secretary, Box 103, Waterville.

Maryland. State Board of Registration for Professional Engineers and Land Surveyors, J. W. Gore, Secretary, 1101 Key Highway, Baltimore 30.

Massachusetts. State Board of Registration of Professional Engineers and Land Surveyors, Office of the Board, Room 34, State House, Boston 33.

Michigan. State Board of Registration for Architects, Professional Engineers and Land Surveyors, H. G. Groehn, Executive Secretary, 1604 Cadillac Square Bldg., Detroit 26.

Minnesota. State Board of Registration for Architects and Professional Engineers and Land Surveyors, Helen D. Carlson, Executive Secretary, 316 New York Bldg., St. Paul 1.

Mississippi. State Board of Registration for Architects, Engineers, O. B. Curtis, Sr., Secretary, P. O. Box 3, Jackson.

Missouri. State Board of Registration for Architects and Professional Engineers, Mrs. C. V. Wall, Secretary, Box 184, Jefferson City.

Montana. State Board of Registration for Professional Engineers and Land Surveyors, H. W. Taylor, Executive Secretary, P. O. Drawer 291, Capitol Post Office, Helena.

Nebraska. State Board of Examiners for Professional Engineers and Architects, R. M. Green, Secretary, 512 Trust Bldg., 941 'O' St., Lincoln 8.

Nevada. State Board of Registered Professional Engineers, S. G. Palmer, Secretary, University Station, P. O. Box 9052, Reno.

New Hampshire. State Board of Registration for Professional Engineers, W. E. Haynes, Secretary, c/o Secretary of State, State House, Concord.

New Jersey. State Board of Professional Engineers and Land Surveyors, T. E. Heathcote, Secretary, 1100 Raymond Blvd., Newark 2.

New Mexico. State Board of Registration for Professional Engineers and Land Surveyors, Mrs. Sybel Clagett, Assistant Secretary, P. O. Box 2074, Santa Fe.

New York. State Board of Examiners of Professional Engineers and Land Surveyors, N. L. Freeman, Secretary, 23 S. Pearl, Albany 7.

North Carolina. State Board of Registration for Professional Engineers and Land Surveyors, R. B. Rice, Secretary, P. O. Box 5151, Raleigh.

North Dakota. State Board of Registration for Professional Engineers, A. L. Bavone, Secretary, P. O. Box 1265, Minot.

Ohio. State Board of Registration for Professional Engineers and Surveyors, R. N. Waid, Secretary, 21 W. Broad St., Columbus 15.

Oklahoma. State Board of Registration for Professional Engineers, Gwynne B. Hill, Secretary, 2901 Classen Blvd., 225 Cameron Bldg., Oklahoma City 6.

Oregon. State Board of Engineering Examiners, E. A. Buckhorn, Secretary, 717 Board of Trade Bldg., Portland 4.

Pennsylvania. State Registration Board for Professional Engineers, Miss Louise J. Franklin, Secretary, 570 Education Bldg., Harrisburg.

Puerto Rico. Board of Examiners of Engineers, Architects and Surveyors, Joaquin Mercado-Cruz, Secretary, P. O. Box 3271, San Juan.

Rhode Island. State Board of Registration for Professional Engineers and Land Surveyors, P. S. Mancini, Secretary, 246 State Office Bldg., Providence.

South Carolina. State Board of Engineering Examiners, Miss M. E. Gibbons, Assistant Secretary, P. O. Drawer 1404, Columbia.

South Dakota. State Board of Engineering and Architectural Examiners, E. D. Dake, Secretary, c/o South Dakota School of Mines and Technology, Rapid City.

Tennessee. State Board of Architectural and Engineering Examiners, W. H. Rowan, Secretary, P. O. Box 1810, Station 'B,' Nashville.

Texas. State Board of Registration for Professional Engineers, T. C. Green, Executive Secretary, 308 W. 15th St., Room 403, Austin 14.

Utah. Representative Committee of Professional Engineers and Land Surveyors, F. E. Lees, Director, 318-A State Capitol Bldg., Salt Lake City.

Vermont. State Board of Registration for Professional Engineers, W. D. Emerson, Secretary, c/o Norwich University, Northfield.

Virginia. State Board of Examination and Certification of Professional Engineers, Architects and Land Surveyors, T. C. Burton, Secretary, P. O. Box 1-X, Richmond.

Washington. State Board of Registration for Professional Engineers and Land Surveyors, E. C. Dohm, Secretary, Department of Licenses, Professional Div., General Administration Bldg., Olympia.

West Virginia. State Registration Board for Professional Engineers, Robert Williamson, Jr., Secretary, 301 Morrison Bldg., Charleston.

Wisconsin. State Registration Board of Architects and Professional Engineers, W. A. Piper, Secretary, 1140 State Office Bldg., Madison 2.

Wyoming. State Board of Examining Engineers, Mrs. Wilma Lang, Assistant Secretary, 201 State Capitol Bldg., Cheyenne.

SUPPORT THE NEW UNITED ENGINEERING CENTER

Satellites Go Commercial—for Communications

H. E. WEPPLER
MEMBER AIEE

Multifold increase in international communication is foreseen within the next 20 years. To meet this situation, the Bell System has proposed a preliminary plan involving 26 ground terminals and active satellites in somewhat random polar orbits, 3,000 miles high. Broadband channels, each accommodating 600 telephone circuits, would be provided. Experimental relaying will be in co-operation with overseas telephone administrations.

THE past year has been a most significant one for engineers and scientists concerned with the international telephone services. They have experimentally verified the feasibility of using satellites for telephone communication, they have been able to set down proposals for a world-wide communications network based on satellites and they have announced plans for the first step toward such a network.

These events are of great social as well as technical significance, because they constitute the first concrete actions leading to the civil use of satellites.

In preparing for this "first," the telephone engineer is not guided by a mere desire for novelty or for a demonstration of ingenuity. His interest is based on firm business logic. The rapid rise in rocket technology has come at the same time as a rapid rise in the need for international communications. The combination of the two trends promises to open a new era in international communication.

PRESENT FACILITIES AND FUTURE REQUIREMENTS

INTERNATIONAL TELEPHONE SERVICE in itself it not new. Already cable and radio facilities gird the world. But all the expected needs of the future cannot be met efficiently with existing methods. Satellite communication systems hold the promise of meeting the rapidly increasing requirements economically and reliably.

For example, the facilities which are used for public telephone service to and from the United States, excluding communications to Canada and Mexico, are shown in Fig. 1. The facilities provide a total of 491 telephone circuits with direct connection to 66 overseas countries or areas and switched connections to 94 others. Of these circuits 226 are on radio, 256 on cable, and 9 on open-wire land line. It is expected they will handle nearly 4 million overseas telephone calls in 1960.

Now four million international calls is not a figure to be sneezed at. But it is only a modest beginning. In the United States, since 1920, while our population has grown some 60%, the number of telephones has increased five times. This is shown in Fig. 2. The greatest increase has been in long-distance usage, which has gone up by more than 30 times in the same period. This gives strong indication of the greatly increased activity of the American people and the extension of their horizons to distant parts of the country.

Similar increases in international communication are foreseen. The principal factors are:

1. At present the United States, with only 6% of the world's population, has 53% of the world's telephones. As the 94% of the world's people outside the United States become more industrialized there will be a tremendous increase in telephones abroad.

2. The expanding horizon of the American people, and all the world's people, is greatly increasing the need to talk together by telephone, and to communicate by transmitting and receiving data and other business communications, and by means of television.

3. Experience has already shown that when it is feasible to provide communication channels of superior quality and in liberal quantities, the public's usage expands rapidly.

Fig. 3 shows the growth in overseas calls from 11,000 in 1927 to more than 3 million in 1959. Estimates show that the demand in 1980 will come to about 100 million. This will call for at least 10,000 international telephone circuits. In addition, private line requirements for digital data, telephone, and teletypewriter service

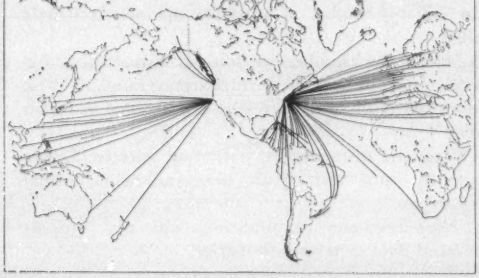

Fig. 1. Countries or areas currently served by direct circuits of the Bell System.

Essentially full text of CP 61-110, presented at the AIEE Winter General Meeting, New York, N. Y., Jan. 29–Feb. 3, 1961.

H. E. Weppler is with the American Telephone and Telegraph Company, New York, N. Y.

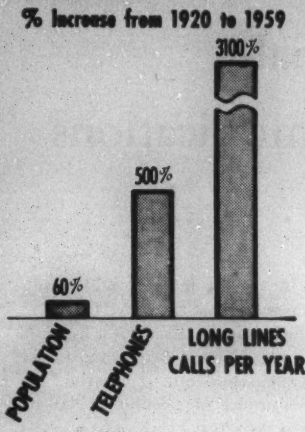

Fig. 2. Comparison of the growth in telephones and long-lines calling rate with population in the United States.

will require additional communication facilities—the equivalent of 2,000 telephone circuits.

A requirement for video transmission channels for closed-circuit and network television is clearly indicated. A conservative estimate is that by 1980 a minimum of two video channels will be needed in each direction between the United States and major world centers.

Such demands for television transmission and for telephone channels in bulk quantities add up to a requirement of many megacycles of base-band width on many international routes. And the 1980 requirements are not the end; by the turn of the century international telephone calls are expected to reach several billion annually.

Except for the relatively short "beyond-the-horizon" microwave systems being used to serve Cuba and the Bahamas, the radio circuits which serve most of the routes shown on Fig. 1 use high-frequency transmission. Conventional microwave systems have not been usable because of their line-of-sight characteristics, requiring repeaters every 30 miles or so.

While high-frequency radio circuits served admirably during the early stages of development of overseas telephony, they cannot be expected to meet future needs for the following reasons:

a. The entire high-frequency spectrum is only 27-mc wide and the number of available channels is strictly limited.

b. The large number of stations using these frequencies and the very great interference range of these stations has resulted in increased interference in recent years.

c. Magnetic disturbances, static and selective fading frequently cause lost circuit time and below-normal transmission.

d. High-frequency transmission will not support wide-band data or television service.

In the past few years submarine cables have taken an important place in the international network. Cables are already in service to Europe, Hawaii, Alaska, Puerto Rico, and Cuba and still others are in the planning stage. However, a submarine cable of the current type provides a bandwidth of only 0.14 mc, while a typical common carrier microwave channel accommodates a baseband of 4 mc and a fully equipped microwave system provides a useful bandwidth of 40 mc. The bandwidth of submarine cables is sure to increase, but the practicable bandwidth of microwave systems seems inherently greater.

Until microwave can be used internationally on a going basis, cables will be the principal means of adding substantially to the international network. Eventually, microwave radio and cable will form a complementary pair, just as in domestic communications, to provide a highly diversified, secure system.

TECHNICAL CONSIDERATIONS

MICROWAVE COMMUNICATION SYSTEMS can use either passive or active satellite repeaters. Passive satellite repeaters merely reflect the signals received from the ground station transmitter without supplying any amplification. Active satellite repeaters are equipped to pick up the signals from an earth terminal, amplify them, and retransmit them to the desired location.

Irrespective of the type of satellite used, the transmission paths will be long compared to the average hops of about 30 miles used in conventional microwave systems. The additional loss as compared to a conventional 30-mile microwave path largely can be compensated for by increased transmitter power, increased antenna directivity, reduced receiver noise, and the use of special modulation schemes to reduce the audible effect of noise. In the case of a passive satellite system the total path loss for ground to satellite to ground must be overcome by means of the ground transmitting and receiving terminals. In the active satellite system the satellite repeater makes up for part of the path loss, thus simplifying the ground equipment requirements.

Tubes for developing more than a few tens of kilo-

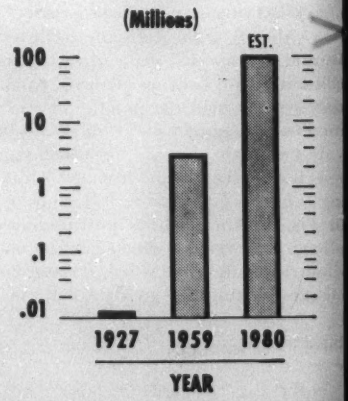

Fig. 3. Growth of overseas telephone calls (note logarithmic scale).

watts in the microwave range are almost impossible today and their cost increases rapidly with increased power. In the case of active satellites, transmitter power is severely limited by the weight of the equipment, including its power supply, and the related costs of orbiting the satellite. Primary power by solar batteries requires several pounds per watt, and the equipment required to convert this prime power into radiated signal increases with increasing power requirements. What all this adds up to is that space communication systems must be designed for the greatest possible economy of signal power.

Antenna sizes are also limited by various technical factors affecting cost, including physical size and weight, the increased accuracy of construction needed to realize the potentially high directivity and the greater accuracy required of the mechanisms that keep them aimed at their intended targets. The use of directive antennas in active satellites requires stabilization and means of controlling the direction of radiation.

The increased power and antenna directivity that can be achieved within these practical limitations is not sufficient alone to insure a satisfactory satellite communication system. The additional transmission advantage required can be obtained, however, by the use of modulation and detection schemes which reduce the effects of noise at the receiving terminals.

As is well known, the use of frequency modulation (FM) makes it possible to obtain improved signal-to-noise ratios and the amount of improvement is proportional to the deviation ratio employed. When an ordinary FM receiver is used, the bandwidth of the receiver must be increased as the frequency deviation is increased. But, increasing the receiver bandwidth admits more noise and if the bandwidth is made too wide the noise will cause the system to "break." Fortunately, there was invented at the Bell Telephone Laboratories in the 1930's an FM receiver which uses negative feedback to control the frequency of the beating oscillator in accordance with the instantaneous frequency of the incoming signal. By this means the "breaking" point can be extended to low signal levels, while maintaining the signal-to-noise improvement resulting from the wide deviation of the transmitted signal. This comes about because wide swing is used on the air, where reduction of noise is so important—but in the receiver, where bandwidth controls the breaking point, the swing is reduced by means of the negative feedback arrangement.

By the use of a maser amplifier, the intrinsic noise generated in the receiver itself can be held to negligible levels and the receiver can be made so quiet that the noise introduced by external sources must be considered. These external noise sources include galaxies, planets, the sun, the moon and other objects in space, including the earth and the atmosphere surrounding the earth. In fact, any matter that has a temperature above absolute zero (—273 C or 0 K) produces thermal noise.

By the use of a maser input amplifier the noise temperature of the receiver can be reduced to about 7 K, compared to 3,000 K for a conventional microwave receiver. In other words, the noise generated in the receiver input circuits is as low as that produced by thermal activity at 7 K. This source of noise is so low compared with other sources that it is not controlling.

Then the important item is the external noise temperature normally seen by a ground terminal receiving antenna. The radio signals transmitted to and from the satellite must pass through the earth's atmosphere. The thickness of the layer encountered depends upon the angle of the radio beam with respect to the earth's surface and is a minimum for signals transmitted directly upward toward the zenith. However, in order to use effectively a satellite moving relative to the earth as a relay point for long-range transmission, it is necessary to direct the radio beam at it throughout a wide range of elevations. The heavy curved lines in Fig. 4 show the temperature effect of oxygen and water vapor absorption on transmissions at different frequencies for various angles of elevation of the main beam of the antenna. The earth itself has a noise temperature of about 300 K and it is necessary to use receiving antennas which have a minimum of back- and side-lobe radiation in order to limit system noise principally to that of the atmosphere. The horn-reflector antenna is being used for this purpose.

It appears from the heavy curves of Fig. 4 that when operating at frequencies below about 10,000 mc, with antenna elevations as low as 5 to 10 degrees, the atmospheric noise will be less than about 30 K.

The sloping lines at the left in Fig. 4 show how cosmic noise varies with absolute temperature and frequency. The lines marked "cosmic noise" and the oxy-

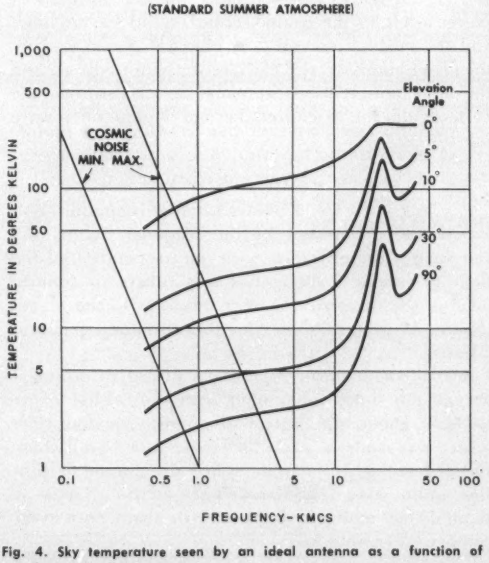

Fig. 4. Sky temperature seen by an ideal antenna as a function of elevation angle and frequency.

Fig. 5. General view of Holmdel site showing transmitting antenna *(left)* and receiving antenna *(right)*.

gen absorption curves define approximate frequency boundaries between 1,000 and 10,000 mc that would be most useful for satellite communications. Frequencies from 10,000 to 16,000 mc are less favorable but might be used. Frequencies above 20,000 mc do not appear suitable for reliable satellite communications due to increased absorption and rain attenuation.

This matter of system noise is very important since it becomes the basis for over-all system design. The desired signal levels at the receiver input must be strong enough to override the noise by a good margin at all times to provide satisfactory service. The engineer has a choice of various system parameters to provide the proper signal level. These include determination of whether active or passive satellite repeaters of the low-level orbiting type or the 22,000-mile stationary type will be used, the antenna gains and the transmitted power levels for the ground terminals and the satellites, and the modulation ratio. In practical system designs, the maser amplifier, the FM receiver with feedback, and the large horn-reflector antenna have constituted the most significant extensions beyond typical microwave practice.

PROJECT ECHO

PROJECT ECHO was a passive satellite communication experiment undertaken by the National Aeronautics and Space Administration with the co-operation of the Bell Telephone Laboratories and others to confirm some of the theoretical considerations as to the practicability of using satellites for long-distance communications.

A 100-foot diameter sphere was placed in orbit approximately 1,000 miles high with the orbital plane inclined about 47 degrees from the equator. The sphere was made of Mylar polyester film ½-mil thick and covered with vapor-deposited aluminum to provide radio wave reflectivity. The satellite travels at about 16,000 mph, circling the earth about once every 2 hours (118 minutes).

The primary communication sites for the initial experiment were the Bell Laboratories installation at Holmdel, N. J., and the NASA-Jet Propulsion Laboratory station at Goldstone, Calif. The terminal at Holmdel was equipped with a 10-kw FM transmitter operating at 960 mc, a 60-foot diameter parabolic transmitting antenna, a 20 by 20-foot aperture horn-reflector receiving antenna, a 3-level maser receiving amplifier using liquid helium to hold the maser near absolute zero temperature, an FM receiver with feedback, and a digital analog converter and other equipment for keeping the antennas pointed at the satellite. Fig. 5 shows a general view of the Holmdel site.

The Goldstone terminal was similarly equipped, but used a frequency of 2,390 mc for transmission, a parametric receiving amplifier (300 K) and 85-foot diameter parabolic antennas for transmitting and receiving.

The satellite provided a communication path only when it was mutually visible at the two terminal stations. On an average day 6 of the satellite's 12 orbits around the earth passed through the area of mutual visibility. The average useful time per pass was 12 minutes, the maximum being about 16 minutes.

Precise data on the satellite location are required for use in properly orienting the ground station antenna which must be controlled to within about 0.2 degree. At Holmdel several methods were used. The primary one was the predicted orbit method using data provided by the NASA (National Aeronautics and Space Administration) Goddard Space Flight Center. This information was fed into a computer to obtain current and predicted orbital information. Predicted orbital data for 2-second intervals in terms of azimuth, elevation, and time were transmitted by teletype to Holmdel and other participating stations in the form of digital data. At Holmdel these data were converted to the analog form used to control the machinery for orienting the antennas. Radar and optical tracking were also provided as safeguards and for comparison.

The signal levels received at Holmdel from Goldstone were found to agree within a db or so of the predicted values and provided a single telephone circuit of excellent quality. To demonstrate the feasibility of using this type of transmission for public telephone service, connections were extended from the satellite communication system into the switched telephone network.

In addition to the tests between Holmdel and Goldstone, the Bell Laboratories installation was used for tests of satellite communication with the Naval Research Laboratory at Stump Neck, Maryland. These tests included facsimile picture transmission. Signals transmitted from Holmdel were also received via the satellite at the Jodrell Bank experimental station in England and at a radio site located near Paris.

SATELLITE ARRANGEMENTS

IN ORDER TO MEET the need for economical overseas service by means of satellites, broadband transmission will be required. To attain a 5-mc bandwidth suitable for 600 telephone circuits or one television channel

using a passive satellite in an orbit 2,500 miles high for service between Holmdel and London or Paris, antennas over a hundred feet in diameter, and several tens of kilowatts of transmitter power would be required. This brings up a number of serious problems.

Consideration is accordingly being given to the use of active repeaters having a power of 1 watt radiated from satellites in more or less random orbits several thousand miles above the earth. Such a repeater could use an antenna with a dipole radiation pattern, and the satellite could be spun to keep the axis pointing in a known direction. If a 60-foot aperture horn-reflector antenna and a maser amplifier with an FM feedback receiver are used at the ground receiving terminal, such an arrangement will provide a suitable signal-to-noise ratio for a 5-mc baseband with an FM deviation of ±50 mc. Since it would not be practicable to use a maser receiver with FM feedback in the satellite, transmission from ground to satellite will require a transmitter power of 1,000 watts with a 60-foot diameter parabolic antenna. To avoid interference at the satellite, different frequencies for transmission and reception will be needed. Each of these frequencies, with suitable guard bands, requires a bandwidth of about 125 mc; the whole totalling 500 mc for a 2-way broadband channel. (See Fig. 6.) Ultimately, for reasons of economy and capacity, it will be desirable to put several channels aboard each satellite.

With a low-powered repeater of this kind, it is possible to operate many satellites in different parts of the sky simultaneously on the same radio frequencies, interference being avoided by means of the directivity of the ground station transmitting and receiving antennas.

The immediate technical problem in such a system is satellite life. It is believed that a 1-watt traveling wave tube can be made with an expected life of 10 years or more and it seems possible to construct the remaining parts of the repeater out of long-life solid-state components. To survive the radiation of space, solar cells must be protected by transparent covers of quartz or other material. These and other technical problems are being investigated by the Bell Telephone Laboratories. The hope is to achieve a 10-year life for the satellite.

Use of low-level satellites such as that just described means that a multiplicity of satellite repeaters are needed to assure uninterrupted service. The use of an active satellite in a 24-hour orbit 22,000 miles above the earth would be visible over one third of its surface and might be used to provide service between points in this area using only a single satellite. However, the means required to place such a satellite in orbit and keep it there, as well as the problem of equipping it with directive antennas arranged for alignment toward the earth are complex. It will require orientation equipment involving electronics, flywheels, gas jets, and the like. Furthermore, the path length would be sufficiently long that transmission time would create a problem for 2-way voice communication, due to the appreciable time lag of one-half second or more between the end of a transmission and receipt of the reply.

Although the stationary repeater holds considerable promise for the future, it seems much farther away for commercial communications than the low-orbit active repeater.

WORLD-WIDE SERVICE USING SATELLITES

THE BELL SYSTEM has prepared a preliminary plan using satellite repeaters to provide service from the United States to many other areas of the world. This plan involves some 26 ground terminals, and active satellite repeaters in somewhat random polar orbits 3,000 miles high. Broadband channels would be provided, each capable of accommodating 600 telephone circuits or one television channel.

Since a given satellite at this height would only remain in the area of mutual visibility between any pair of terminals for periods up to about 30 minutes, enough satellites must be provided so that at least one will be visible a very large percentage of the time. Rough estimates indicate that about 50 satellites will suffice for the 26 terminals in the plan studied. Fig. 7 shows the ground station locations and connections assumed.

In the transmitting direction the ground stations would use 1-kw transmitters and 60-foot diameter steerable dish antennas. In the receiving direction there would be 60- by 60-foot horn-reflector antennas and maser receivers. In order to avoid interruptions to service in switching from one satellite to another as the satellites pass through the mutually visible area, duplicate transmitting and receiving antennas and radio

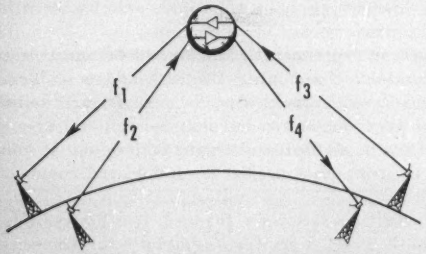

Fig. 6. Frequency plan for a 2-way broadband channel aboard an active satellite.

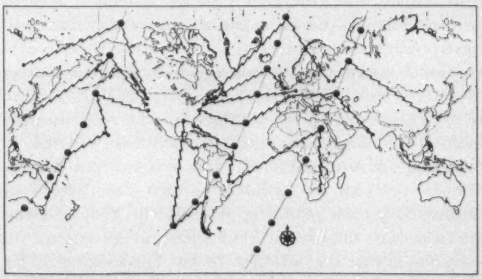

Fig. 7. Plan illustrating use of 50 satellites in random orbits for world-wide communication system.

equipment would be required at each terminal. The terminals also would require standby radio equipment, regular and emergency power supplies, land, buildings, and access roads. The estimated cost of a typical ground station providing one broadband channel in each direction of transmission is $2.5 million, exclusive of carrier terminal equipment.

The present cost of launching even comparatively light satellites appears to be several million dollars. However, large vehicles of the future might launch large satellites, or might launch many smaller satellites at one time for a cost comparable to present-day launchings. Based on a forward look the cost per satellite equipped for one 2-way broadband channel has been estimated at $1 million.

The estimated cost of the 26 ground installations indicated in Fig. 7 plus the 50 satellite repeaters comes to a total of $115 million. This provides one broadband channel. To add a second 2-way broadband channel the satellite costs would about double, due to weight considerations, and the additional ground station equipment would cost about $200,000 per station. Thus, the cost of providing the basic facilities for 600 telephone circuits and for television service between each of the 13 pairs of world-wide terminals would total approximately $170 million. With such a system fully loaded, the cost per telephone-circuit-mile would compare very favorably with that of the latest, most efficient overseas cable now being designed.

The cost of the satellite system assumes that the telephone common carriers would own the satellites and contract with others to place them in orbit.

FREQUENCY REQUIREMENTS

As mentioned earlier, a satellite communication system which provides one 2-way broadband channel requires a total radio frequency bandwidth of 500 mc. In order to meet the 1980 circuit requirements it will be desirable to pack four such broadband channels into each active satellite, making for a frequency requirement of 2,000 mc.

The discussion of Fig. 4 brought out the conclusion that the best frequencies for satellite communications are between 1,000 and 10,000 mc. Frequencies up to 16,000 are less favorable but might be used.

The sharing of frequencies by satellite communication systems and ground microwave systems is fraught with problems. Satellite system ground transmitters will have powers up to thousands of times those used in conventional microwave systems and so are potent sources of interference. Conversely, the ultrasensitive satellite receivers are highly vulnerable to otherwise inconsequential radiations from ground microwave systems.

Fitting satellite communications systems into the frequency spectrum is a problem requiring the utmost of careful, long-term planning. Already the Federal Communications Commission (FCC) has put all microwave users on notice that changes in current usage may be required to meet possible requirements for space communication needs.

Furthermore, the problem is not limited to this country. nternational co-operation and co-ordination are essential. The subject of frequencies for space communications is on the agenda for the next meeting of the CCIR (International Consultative Committee on Radio) at New Delhi, India, in 1963, and the Administrative Radio Conference of the International Telecommunication Union at Geneva, Switzerland, in 1959 adopted a recommendation that an Extraordinary Administrative Radio Conference be held in the latter part of 1963 to take up the question of frequency allocation for space telecommunication.

THE NEXT STEP

The transition from proposal to reality is underway. Encouraged by the great success of Project Echo in confirming the fundamental predictions of feasibility of satellite relaying, the Bell System is now preparing for a trial of an active satellite. It is proposed to provide experimental relaying between the United States, the United Kingdom, and continental Europe.

The active satellite will contain one broadband amplifier and modulator, capable of handling a baseband of several megacycles, as compared with the single voice channel relayed via the passive Echo satellite. The commercial satellite described earlier would have two broadband amplifiers, one for each direction of transmission. However, the experimental satellite will permit reversible 1-way operation for tests of multichannel telephone transmission or television transmission, in either direction. Alternately, 2-way transmission will be feasible for a limited number of 2-way communication channels for telephone, data, and the like. For 2-way operation, one-half of the passband of the repeater will handle transmission in one direction and the other half of the passband will accommodate the opposite direction. The repeater configuration will be such that the satellite transmitter radiates only when the satellite is illuminated by the ground station transmitter.

The ground station will be at Rumford, Maine, and will be comparable with that used for Project Echo. In this case the radio frequencies are proposed to be in the neighborhood of 4,000 and 6,000 mc.

The Bell System expects to assume the cost of putting such a satellite into orbit. The intention is that the experimental relaying will be in co-ordination with the overseas telephone administrations, the way that overseas communication by radio and cable has been handled for many years.

Such an experimental satellite will be mutually visible at Holmdel and in the United Kingdom or Western Europe several times a day, for periods of 30 minutes or so. With one or two satellites in orbit at a time this will provide highly useful testing periods but, of course, not the continuity needed for full-fledged commercial service.

Further steps are being planned. It is not possible to establish, as yet, a firm time-table for a full commercial system but it is coming—and coming fast.

Thermal Behavior of Silicon Carbide Valve Blocks

N. E. BOLEN
ASSOCIATE MEMBER AIEE

BONDED resistors made of semiconducting silicon carbide are widely used as valve blocks in lightning arresters. During severe duty they may fall thermally; it is the purpose of this article to develop analytical means of studying the thermal behavior during transient duty.

These resistors are nonohmic in nature, displaying high resistance at system voltages but having relatively low resistance during high-current impulses. In addition, the d-c resistance of SiC valve blocks decreases with increasing temperature. The electrical behavior of such resistors may be described by equation 1.

$$I = \sigma\, e^{-B/T}\, V^{\beta} \tag{1}$$

B and β are constants, and σ is a parameter similar to conductivity.

If a voltage pulse is applied to a valve block, internal heat is generated throughout the body of the resistor. This problem of a bounded solid body generating internal heat is a classic one in the study of differential equations. For a valve block, the transient heating is governed by equation 2.

$$\nabla^2 T + \frac{\sigma\,(r, \theta, z)\, e^{-B/T}\, V^{\beta+1}}{k} = \frac{cw}{k}\frac{\partial T}{\partial t} \tag{2}$$

The equation governing the transient heating of a valve block is nonlinear; consequently, it cannot be solved by standard methods. A numerical solution can be obtained by using finite difference equations, and this was the procedure followed. This method of numerical analysis made it possible to study mathematically the transient thermal behavior of valve blocks subjected to short voltage pulses. The necessary calculations were carried out on an IBM *704* computer.

Fig. 1 shows a typical set of results as obtained from this analysis. This shows valve block temperature as a function of time for several amplitudes of applied voltage pulses. The exponential nature of these curves shows how progressive thermal runaway can occur.

The cases analyzed in this study involved the application of a constant-amplitude voltage pulse to the valve block. This simulated the condition of a switching surge discharge through the block. The analyses showed that during a two-millisecond surge there is no appreciable heat transfer, either from one part of the body of the block to another or from the block to the surrounding ambient. Therefore, any small path of higher conductivity than the remainder of the block can heat up independently during such a surge and possibly lead to localized failure.

It is recognized that present valve blocks are not uniform throughout. There may be a considerable variation in parameters from point to point within the resistor. Analyses carried out on resistors having nonuniform conductivity have shown that localized thermal failures may occur, whereas a uniform valve block will be more resistant to thermal runaway.

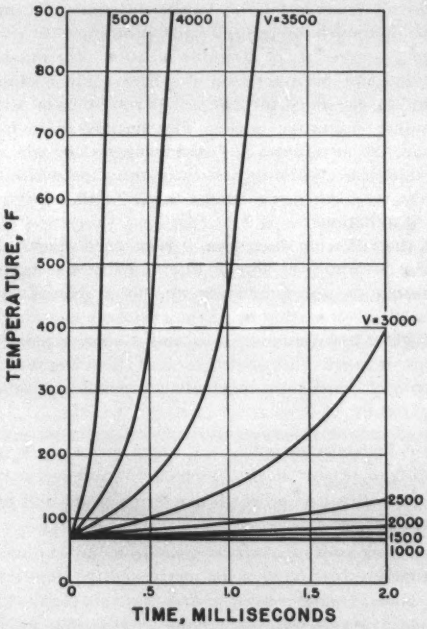

Fig. 1. Temperature vs. time for various applied voltages.

The exact nature of conductivity variation within a single resistor is only vaguely known because of the difficulties involved in obtaining experimental data. Nevertheless, there is every reason to believe that such nonuniformity exists. Reducing this internal nonhomogeneity may be a more effective means of building better valve blocks than merely using material of higher intrinsic strength. Alternatively, for a given degree of nonuniformity in material, a small diameter valve block may be better thermally than a large one.

Digest of paper 61-46, "A Mathematical Study of the Thermal Behavior of Silicon Carbide Valve Blocks," recommended by the AIEE Protective Devices Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N. Y., Jan. 29-Feb. 3, 1961. Published in AIEE *Power Apparatus and Systems*, April 1961, pp. 109-115.

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Grounding of D-C Structures and Enclosures

D. C. HOFFMANN
MEMBER AIEE

THE GROUNDING of supporting structures and enclosures for d-c power circuits and apparatus has been a controversial subject ever since metal-enclosed power rectifiers and switchgear came into use in the electrochemical and other industries. Many users of d-c equipment naturally followed the well-established a-c practice of solidly grounding enclosures through a low-resistance conductor. Relatively few of these equipments included sensitive grounding protective relays. Many cases of serious injury and damage resulting from ground faults that might have been avoided by the use of grounding protective relays have been described earlier.[1]

The grounding of enclosures through a protective device of some sort is no longer questioned by most users, inasmuch as ground-fault protection is recognized as a necessary or desirable function. The question that has not been resolved is whether the enclosure should be grounded through a high-resistance or a low-resistance protective device. The purpose here is to present the advantages and disadvantages of high- and low-resistance grounding of d-c structures and enclosures and to set forth guide rules for use in the design of new installations.

In the following discussion, it is assumed that the d-c system is grounded either intentionally for normal operation or unintentionally due to a ground fault external to the enclosure. If the enclosure is grounded through a low-resistance path and a short circuit develops between the enclosure and the ungrounded polarity of the d-c power circuit, personnel may be endangered by

1. A high-current power arc, which may cause severe burning of persons in the immediate vicinity.
2. A brilliant flash, which may cause fright and temporary blindness.
3. Flying objects, such as glass from an exploding instrument, splattering of hot metal, and the like.
4. High enough voltage between enclosure and ground to cramp muscles, making it impossible for the victim to free himself.
5. Consequential injury, such as broken bones and bruises due to fright, attempt to escape, or sudden release of cramped muscles, causing the victim to fall or strike other objects.

All five of the above personnel hazards may exist during a ground fault in an enclosure grounded through a low resistance, whether or not a protective relay is used. However, if the enclosure is grounded through a high resistance, hazards 1, 2, and 3 cannot exist because there is no power arc. The only hazards are 4 and 5. Even in the case of hazard 5, the danger is less because there is no flash, arc, or hot metal.

High-resistance grounding prevents serious damage to equipment, but it is more difficult to install and maintain. Low-resistance grounding may result in greater damage to equipment, but it is easier to install and maintain.

Taking into account the advantages and disadvantages of high- and low-resistance grounding, the following rules may be used as a guide in the design of new installations:

1. In d-c systems rated above 300 volts, in which one of the power conductors is intentionally connected to ground through a low-resistance connection and in which the structures and enclosures are to be located indoors in a dry place where access is limited to authorized personnel, all d-c structures and enclosures should be insulated from ground and from other close-connected units. All such insulated structures and enclosures should be connected to ground through one or more high-resistance ground detector relays arranged to disconnect all sources of power upon the occurrence of a fault between the power circuit and the structure or enclosure.

2. In d-c systems rated above 300 volts, in which no power conductor is intentionally grounded but which are characterized by unintentional grounds of varying magnitudes in varying locations and in which the structures and enclosures are to be located indoors in a dry place where access is limited to authorized personnel, the method of grounding should be optional with the purchaser or user. The recommendation would be the same as in case 1. The alternative is to ground the structures and enclosures through d-c and a-c current transformers with instantaneous overcurrent relays.

3. In d-c systems of any voltage rating, in which no power conductor is intentionally grounded, or in which a power conductor is grounded through a high resistance (such as ground detector), *or* in which the structure or enclosure is to be located outdoors or in a normally damp place, *or* where there is unlimited access, all structures and enclosures should be solidly grounded through d-c and a-c current transformers with instantaneous overcurrent relays.

Digest of paper 61-67, recommended by the AIEE Chemical Industry Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N. Y., Jan. 29–Feb. 3, 1961. Published in AIEE *Applications and Industry*, May 1961, pp. 106-12.

D. C. Hoffmann is with the General Electric Company, Philadelphia, Pa.

REFERENCE

1. Recommended Grounding Practices for Single-Polarity Direct-Current Structures, AIEE Committee Report. AIEE *Transactions*, pt. III *(Power Apparatus and Systems)*, vol. 76, Oct. 1957, pp. 784-90.

An Engineer Looks at TV Programming

ALLEN B. DU MONT
HONORARY MEMBER AIEE

To offset the low cultural and intellectual level of television programs in the United States, Dr. Du Mont proposes a Government-sponsored network to inject an antidote of high-level programming into the present banal fare offered the public.

THIS honor accorded me by the Institute, one of the highest possible for a man to receive, is an honor that, I know, is not bestowed lightly nor without the most careful deliberation; witness the names of other men similarly honored—Marconi, Edison, and Herbert Hoover. I accept the election as an honorary member with the deepest humility.

In listening to the introduction by Dr. Goldsmith, I could not help but be struck by the realization that a great deal of my life has been devoted to the development of television—both technically and commercially. This being true, I should probably sit quietly in my study—or in my case, on my boat, and contemplate with immense satisfaction that the United States is almost completely saturated with television.

The most recent figures given by *"Television Magazine"* show over 47 million television homes, a large percentage of which have more than one receiver. Income of stations and networks for the sale of time alone exceeds $1 billion. Talent costs, stage hands, films, technicians, and executives costs add up to an industry that goes far beyond anything I or my associates envisioned in the formative years just prior to World War II and following it.

To go a step further, average television set viewing per home is over 5 hours a day. This means that television sets are in operation approximately 237 million hours a day with one, two, three, or an entire family group watching.

Now, probably the last thing that I would purposely want to do would be to agree with the Federal Communications Commission (FCC). Because of their past actions—inexcusably stubborn and unrealistic in my view—we have today less than three full television broadcasting networks. There is no fourth network—the Du Mont network—primarily because, I believe, the Commission some years ago refused to believe the industry when it said that ultrahigh-frequency stations and very-high-frequency stations could not compete on equal terms in the same market areas.

Address of Dr. Allen B. Du Mont at the AIEE Summer General Meeting, Cornell University, Ithaca, N. Y., June 18-23, 1961, on the occasion of his award of honorary membership in the Institute.

Allen B. Du Mont is with the Allen B. Du Mont Laboratories, division of the Fairchild Camera and Instrument Corporation, Clifton, N. J.

LOW CULTURAL LEVEL OF TV

TODAY, that is past history. I do want to agree with some of the statements made by the *new* chairman of the FCC in his now quite famous "vast wasteland" speech. The young, energetic, and no doubt ambitious Mr. Newton A. Minow detailed in no uncertain terms the trash, trivia, and violence that characterize a large percentage of both network and local television programming.

Many and many have been the evenings that I have gone from channel to channel on my television receiver with the hope of seeing decent drama, important personalities and discussions, good music, contemporary or classical dancing, or the opera.

We in the New York metropolitan area are more fortunate than those in other areas. We have seven channels and stations from which to choose. When a network does originate a public service program, we see it in New York. Not so in other cities with two or three stations owned by stockholders anxious for every cent of income. In most cases they simply don't carry the public-service programs put on by the networks.

I do not, and I hope Mr. Minow, does not claim to be the Great White Father who shall judge what shall be seen and what shall not. Certainly the people themselves have the right to choose. But in most cases, you have to watch the mayhem, the froth, and the gun fight on main street—or you don't watch anything. That's all there is, a large part of the time.

How can 47 million television sets be tuned to this kind of production 5 hours and more a day? My reaction has been that of having created a Frankenstein monster. Yet I am here today, honored by you because I helped make this possible. Rather than honored, perhaps I should be censored!

Yet, others have received honors for achievement and for service, and their creations also have been put to uses which you and I disapprove, and in some instances, wish fervently had never been developed.

The situation seems to be that almost anything is technically possible. Yet man, somehow, seems to find a way to ruin the technical achievement in actual usage. From the talking machine came "rock and roll." From radio came soap operas. From the motion picture, we now have the most lurid and suggestive themes and photography. From the greatest technical achievement of all, atomic energy, we live in constant fear of a world that will destroy itself.

Perhaps I am too pessimistic—too concerned with mankind's misuse of his own technology and achievements. In our society an engineer can create; he can develop; but he cannot control the ultimate utilization. As engineers we must, I am afraid, be content with the

role of the originator and leave it to those with other functions to use the developments in the best interests of mankind.

We have digressed slightly. The beginning of this discussion dealt with the present programming pattern in the television broadcasting industry. I stated that neither Mr. Minow, nor I, nor any other human being can tell another American what he should see and what he should not see on television.

I am afraid the fact must be faced that television programming which would satisfy a Ph.D would not be acceptable to his milkman. It has been proved by statistics that the lower a family is on the economic scale, the more time is spent on television viewing. Advertisers who spend millions of dollars on television are not stupid. The program ratings tell them which programs attract the larger audience. If it is a horse opera, a "whodunit," or a crime series, that is the program he will present.

What I am saying is that the people really do choose the type of programs that are shown. By the people, I mean the large majority who look upon television purely as entertainment and escape. Neither Mr. Minow, nor Congress, nor the President of the United States can force them to look at current affairs, public affairs, or cultural programming.

GOVERNMENT-SPONSORED NETWORK ADVOCATED

THIS THEN is the pity, and also the real void and the vacuum. Television programming, by and large, is for the majority. Television is competitive, and each network and station competes for that large majority. I have tried to determine if there is any answer, and I think that there is.

First, it should be realized that the finest type of programming from an informational and cultural standpoint does not get sponsorship from the large advertisers. There are, of course, exceptions. But from a purely business and economic standpoint, sponsorship and even spot announcements go to the programs and stations that attract the large volume of viewers. The programs must be aimed at a mean level of cultural and intellectual interest.

Where shall the minority go then for intellectual stimulus from the phosphor screen? I think that they must turn to the United States Government. All of my life I have advocated as little government participation as possible in the personal and economic life of America. My friends— both in and out of the television industry—may be shocked, but I believe that the Government of the United States is the only possible sponsor for programming of a noncommercial, intellectual, and informative type. Why? Because television is a national medium, and the costs to present programs from coast to coast and from gulf to border are extremely high. Someone has to pay, and someone has to make the frequencies available so that it can be a truly national service.

Instead of threatening the industry as did Mr. Minow last month, I suggest he start swinging an axe within the FCC to grind out the necessary channels to add a fourth, noncommercial, government-sponsored network which will reach every possible community in the United States. I suggest he start his own personal lobby with Congress and the President to get the funds needed to launch this network and to program it properly. I do not think it necessary to point out that the formation of and the legislation to establish this network must be such that it is completely removed from political control—even that of the President. I have noticed on recent news telecasts that the cameras record practically every one of President Kennedy's sneezes—this since the Minow speech, and indicating fear and political domination by even our commercial networks.

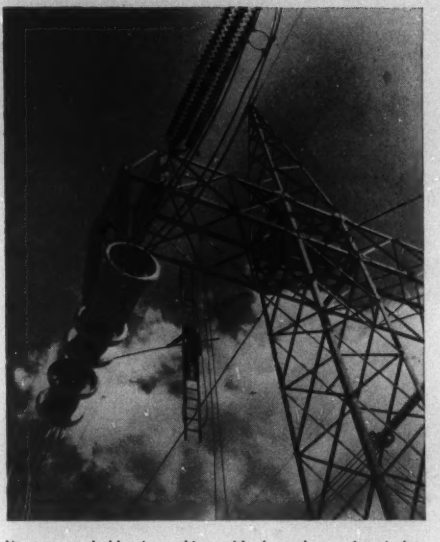
I should like to point out that this proposal for a government supported network is neither revolutionary nor untried. I think I have watched as much or more television programming here and in other countries as most persons in the United States, with viewing that goes back to 1927.

The quality of programming presented in England, France, Italy, and Germany by government-supported stations is very impressive. In England commercial stations compete directly with those owned by the government-supported British Broadcasting Corporation (BBC). Though the commercial stations command large audiences—so also do the BBC stations. The programs and presentations of each—commercial and governmental—vie with each other for audience, and the resulting presentations are better because of it. No—this is not a revolutionary nor a socialistic proposal. It is one that makes extremely good sense in view of our programming problems. Again, however, we need some sort of separate corporate organization like the BBC, which is completely removed from any political pressure. Publicly owned television is too strong a tool for any type of partisan political use.

We are spending over $40 billion for defense, space projects, and maintenance of our arms establishment. I plead for some millions and for some men with guts to bring culture and information to the television screen. This is a challenge to you, Mr. Minow; you can't leave it in the lap of the commercial broadcasters, and you can't solve the problem through fear and pressure. The economics of the industry are against it. We need a completely independent government-sponsored television network, and we need it badly. The cost should run in the neighborhood of a few dollars per television set per year. And believe me, such a proposal makes much more sense than pay-television where the cost per set per year would be very high and the type of programming limited.

Personally, I would like to stop crying about the poor programming on television. Instead, let us give the commercial networks a real run for their money with top-notch programming on a new government-supported independent network designed to satisfy the true needs of our children and the cultural and intellectual requirements of the country's more discriminating minorities.

Apple Grove Test Line Energized



Lineman on ladder is working with decoupler used to isolate the three lines for radio-influence measurements. The coupling capacitor has not yet been connected.

The Westinghouse–American Electric Power extra-high-voltage test line at Apple Grove, W. Va., was recently energized at 775 kv. The chief objectives as well as the physical features of this project are outlined.

AN extra-high-voltage test transmission line at Apple Grove, W. Va., was energized on June 22, 1961, at 775,000 volts. When the line was energized, it marked the start of a 5-year research and test program to develop the information and experience needed to transmit large blocks of power at voltages up to 750 kv—more than twice the operating voltage of most commercial systems in this country today.

The 750-kv project was announced last spring by American Electric Power Service Corporation and Westinghouse Electric Corporation, cosponsors of the program. The new test project will provide a continuation of the investigations begun by the two companies at Brilliant, Ohio, in 1946, when they built and operated the 500-kv Tidd test project.

Other companies participating in the project are: American Bridge Division of United States Steel Corporation; Armco Steel Corporation; Kaiser Aluminum and Chemical Corporation; Lapp Insulator Company, Inc.; Ohio Brass Company; and The Thomas & Betts Company, Inc.

PRIME OBJECTIVES

THE PRIME OBJECTIVE of the project is to obtain data on corona loss and radio-influence (RI) performance of conductors at a nominal voltage of 750 kv to determine technical and economic feasibility of transmitting large blocks of power at this extra-high voltage. The information and data accumulated over the 5-year test period are expected to provide the basis for design of future equipment for this extra-high-voltage range.

Information on conductor size and configuration, insulators, spacers, bushings, connectors, hardware, and structural data will be of value in determining line design. Operating experience with transformers, lightning arresters, coupling capacitors, and line traps will help in the future design of terminal apparatus for 750-kv operation.

PHYSICAL LAYOUT

THE new test line is constructed on a possible future generating site for the Appalachian Power Company at Apple Grove, W. Va., about 25 miles up the Ohio River from Huntington. The Appalachian Power Company is one of six operating companies in the American Electric Power system.

The test line is connected to a tap-off of a double-circuit line between South Point, Ohio, and the Philip Sporn plant at Graham Station, W. Va. As shown in Fig. 1, the 138-kv tap feeds the test line through a 3-pole load-break disconnect switch to the 138/750-kv autotransformer and then to a 750-kv bus structure. Originating at the substation bus and extending from it are three 2,400-foot-long 3-phase lines, forming a "T." Conductor sizes on the three line sections are all different. A control and instrument house is located in the 138-kv switchyard near the 138-kv load-break switch and 750-kv autotransformer.

The entire 138-kv and 750-kv areas are fenced in; the single gate providing access to the 750-kv substation is interlocked with the 138-kv load-break switch so that the gate cannot be opened when the line is energized.

Based on experience at Tidd and Leadville* and

*This test line was built by Public Service Company of Colorado in 1956. A 4-year test program was completed in 1960 on the 10,000-foot-elevation line at voltages up to 500 kv.

other high-voltage projects, calculations were made to select the best conductor size for 750-kv operation. One of the three line sections uses conductors of 1.382-inch-diameter (1,272 MCM) steel-reinforced aluminum conductor (ACSR). The second line section uses a smaller conductor on all three phases: 1.196-inch-diameter (954 MCM) ACSR. The third line uses a combination of the two sizes: the two outer phases use the smaller cable; the center phase uses the larger, since this conductor has greater voltage stress on its surface.

The 3-phase lines use bundled conductors; that is, four separate conductors on 18-inch centers comprise each phase.

SPECIAL FEATURES OF THE LINE

Two special features of the line warrant particular attention: simultaneous independent RI readings can be taken on each of the three lines; and since no load is supplied by the line, heating current is provided to simulate actual system operation.

Simultaneous Readings on All Three Line Sections. To permit simultaneous independent RI readings on each of the three lines, decouplers (blocking filters) for RI frequencies have been installed between the three lines so that the interaction of the radio noise generated on one line section will be minimized with respect to that produced on another. Thus, RI measurements on each of the three line sections are independent determinations, even though all three lines are fed from a common bus.

Heating Current To Simulate Actual Loading. The primary need for current is to keep the conductor slighty above ambient temperature in order to prevent condensation on the line, which generally increases the corona loss and radio noise generated.

Load current is not ordinarily present on extra-high-voltage test lines. The Apple Grove project is unique in that a way was found to produce current in the test conductors without uneconomical power transmission.

To achieve this objective, the four conductors in each phase bundle are insulated from each other, connected in series, and then a current is circulated through the four conductors of each phase by means of a transformer located at the station end of each phase. A series capacitor is used with each transformer to maximize current. This arrangement keeps the conductors warm, as in normal use, with a minimum drain on the power system. Heating current thus circulated is equivalent to more than 1,000,000-kva load on each test line.

However, the connection problem for all devices was complicated by the fact that each conductor in the bundle had to be isolated for 60-cycle current instead of being electrically tied to the others. The method does not result in radio-frequency isolation between conductors in a bundle, however, since bypass filters at the line terminals keep all conductors at the same potential for high-frequency currents.

DATA ACCUMULATION

THE TESTS will be completely instrumented, using magnetic-tape data-logging equipment to allow maximum information to be accumulated and analyzed. Effects of various atmospheric conditions will be assimilated into this data for proper statistical analysis. Comparison of the Apple Grove data with that of previous high-voltage projects, such as the Leadville and Tidd lines and others, will allow evaluation of test procedures, instrumentation, and verification of results.

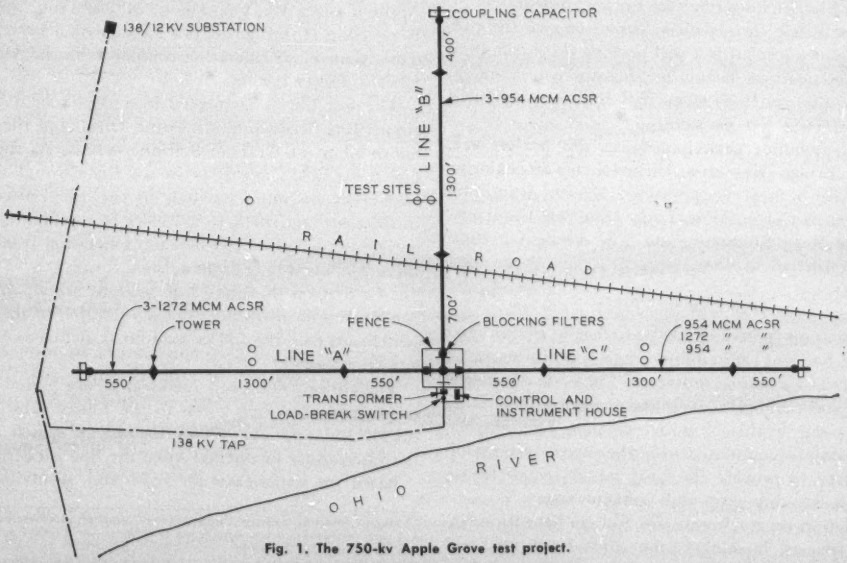


Fig. 1. The 750-kv Apple Grove test project.

Readings of about 50 test quantities on the line will be taken by the data logger and recorded every 20 minutes. Whenever test readings fall outside predetermined limits, the data logger will scan and record readings every 2 minutes until the values fall back into line.

Readings taken will include temperature, relative humidity, air pressure, wind direction and velocity, radio influence, corona loss, rainfall, and air contamination.

RI Measurements. Six instrument houses are located at the approximate mid-point under each of the three line sections. Used to take RI measurements, three under each line are located 100 feet from the center phase; the other three are 200 feet from the center phase.

The three meters in each group are all of different design and are based on three different theories of RI characteristics. One is the well-known Stoddart meter; the Griscom meter and Trebby meter are recent designs. Simultaneous readings will be taken on all three to permit evaluation and comparison of the instruments and data.

In addition to these 18 instrument locations for taking line RI measurements, three additional meters are located about 500 feet away from the lines to measure ambient radio effects, whether from radio transmitters or atmospherics (lightning).

The Fiberglas RI instrument houses are about 6 feet square and 7 feet high to the ridgepole.

Corona-Loss Measurements. Corona-loss wattmeters are located in each phase of each test line. They record the energy loss by using the voltage from a one-turn tap at the high-voltage end of the 750-kv transformer winding, and the in-phase component of current into the test lines. The corona-loss measuring equipment is necessarily mounted at a location which is at a high potential with respect to ground. An ultrasonic beam is used to link the measurement site with the grounded data-logging equipment.

The 138/750-kv transformer at left supplies 750 kv for line into substation. At top right is decoupler for isolating the three line sections from each other for RI noise. The coupling capacitor to ground has been temporarily removed.

Bundle spacers consist of single stainless steel wire stranded upon itself in a flexible loop, with conductor clamps at 90-degree intervals. The spacers are located at 250-foot intervals along the span to maintain conductors in an 18-inch-square configuration.

Contamination Readings. Two devices are used to measure air contamination. One is a conventional smoke photometer, which indicates the amount of dirt and other particles in the air by measuring the proportionate diffusion of light caused by these particles. The other is a new device which uses a high-voltage rod. Dirt particles in the air approaching this rod cause breakdown of the air in its vicinity. The amount of resulting RI noise can be measured and compared with the amount in the test lines.

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OERSTED

and the Discovery of Electromagnetism

Part III

BERN DIBNER
FELLOW AIEE

This is the third article of the series on the contributions of Oersted and his contemporaries to electrical science.

Oersted continued his experiments and published the accumulating results in several journals. In the very journal (Schweigger's) that first carried the text of Oersted's announcement, there had appeared, a few pages farther on, additional experiments under the title "New Electro-Magnetic Research." It revealed that the magnetic effect of a conducting wire depended on the "quantity" of electricity and not on its "tension" and that thus, a battery with larger plates would be more effective than one with small plates; that a suspended closed current-carrying loop might be turned by a magnet, and that such a loop had a north end and a south end, just like a magnet. This addendum may well be considered as a supplement to the original communication. By using a cell consisting of a copper vessel holding the electrolyte and immersing a zinc plate of 100-square-inch surface, Oersted was able to observe a magnetic effect at a distance of 3 feet.

Once Oersted's discovery was exposed to the analytical minds of his fellow experimenters, a flood of new interpretations, modified procedures and involved theories was advanced by many experimenters who were ready to treat their own work as though it were the prime discovery itself. Faraday attempted to bring some order into the mounting number of fresh announcements and reports of discoveries in the eight months following Oersted's disclosure. He gave clear and full credit to Oersted for his discovery, but even Faraday's voice was dimmed by the many new announcements and claims of the early 1820s. Some were ready to ride the bandwagon, others were ready to label Oersted's discovery just a lucky accident. Recognition of the importance of Oersted's discovery was spontaneous and was immediately followed by a shower of congratulations, honors, and awards. He was elected to fellowship in many learned societies and the Royal Society of London awarded him the Copley Medal; the Institut de France presented him with a prize of 3,000 gold francs, a prize similar to that presented to Davy for his discoveries in electrochemistry.

AMPÈRE'S ELECTRODYNAMICS

LESS THAN TWO MONTHS after the publication date of Oersted's announcement, news of his discovery had reached Paris via Geneva, where Prof. de la Rive repeated the Oersted experiment. This announcement occurred at a meeting of the Institut de France at a session held on Monday, September 11, 1820, at which André-Marie Ampère (1775-1836), professor of mathematics at the École Polytechnique, was present to listen to the announcement made by Arago. Ampère recognized the importance of the description of Oersted's experiment and 7 days later presented a paper at the Académie des Sciences in which he mathematically analyzed Oersted's work and added some clarifying experiments of his own to prove that an electric current was capable of creating a full and true magnetic field. The positive position of a magnetic needle in its relation to an electric current was here first specified. This was then extended to conductors having spiral or helical shapes, indicating the cumulative values of the magnetic forces. Ampère then generalized a theory by which he analyzed the electromagnetic forces circulating within a magnetic molecule as the basis of its magnetic property. Philosophers thereby grasped the deep significance of providing man with a means of fashioning magnetic fields without dependence on lodestones or steel bars, for an easily controlled electric current now provided an even stronger form of magnet, as shown by Ampère. With this demonstration Ampère had made the great leap forward for he showed that not only could an electric current *influence* a magnet but it was in itself capable of *producing* magnetism. He showed, further, that two solenoids carrying currents behaved like true magnets in polar attraction and repulsion. Until then only the lodestone was held to be the source of magnetic power. A new and more powerful agency for creating magnetism had thus been discovered. By mathematical analysis Ampère predicted electrodynamic behavior, subsequently proved by experiment.

It was pointed out that what Newton had done for

This article is part III in a serialization, in four parts, of the book of the same name published by the Burndy Library, Norwalk, Conn.

Bern Dibner is chairman of the board, Burndy Corporation, Norwalk, Conn.

gravity, and Coulomb for electrostatics, Ampère had now described and charted for electrodynamics.

Arago, like Seebeck, was at the first reports skeptical of the Oersted claims but then was prompted to remark that "the vast field of physical science perhaps never presented so brilliant a discovery, conceived, verified and completed with such rapidity." The able Faraday commented, "It is full of important matter and contains in few words, the results of a great number of observations; and with his second paper, comprises a very large part of the facts, that are as yet known relating to the subject" and "His constancy in the pursuit of his subject, both by reasoning and experiment, was well rewarded in the winter of 1819-1820 by the discovery of a fact of which not a single person beside himself had the slightest suspicion; but which, when once known, instantly drew the attention of all who were able to appreciate its importance and value." To this Ampère added, "M. Oersted has forever attached his name to a new epoch. . . . This learned Danish professor has opened, by his great discovery, a new approach for physical research." Investigators everywhere soon busied themselves with the extension of magnetism to combined electrical and chemical experiments.

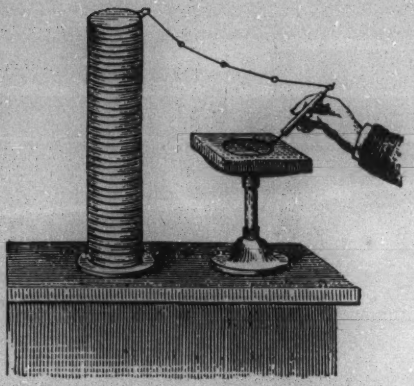
Experiments by Ampère had disclosed that when electric currents were passed in the same direction through two parallel wires free to move, they caused mutual attraction; if the currents flowed in opposite directions, they repelled one another. These observations provided the second law of electromagnetism. (The first law is credited to Oersted and is to the effect that an electric current generates a magnetic field circular to the flow of the electric current.) Ampère determined the rules for relating the direction of flow of a current in a wire to the direction in which an adjoining compass needle would point, and illustrated it by a simple means so that it could be memorized. If, he stated, one were to imagine a little manikin (called a "bon homme d'Ampère" by his colleagues) to swim in the direction of the current and to face the needle, then the north pole of the needle would be the direction of the left arm and the south pole that of the right arm. The pointing of the needle could thereby be predicted and thus the experimenter acquired command of an additional set of electrophysical relationships with which to work. He further determined that the force of the attraction or repulsion between current-carrying parallel wires would be directly proportional to the strength of the current and inversely proportional to the square of the distance between the wires. Twisting the wire into a helical form, or solenoid, and having a current flow through it caused it to behave like a magnet having a north pole at one end and a south pole at the other. If such a coil were to be freely suspended and still carry current, it would pivot so that its magnetic field would align itself with the field of the earth's magnetism and so duplicate the behavior of a compass needle.

Ampère was led to the hypothesis that terrestrial currents of electricity circulating from east to west about the earth might be responsible for its magnetic field. From this came Ampère's proposal for the construction of an astatic galvanometer to negate the stray magnetism in the measurement of an electric current. Ampère repeated, on October 2, 1820, the suggestion made by Laplace that the response of a magnetic needle to a current-carrying wire could be made the principle of an electromagnetic telegraph. One had simply to identify a needle with a letter and by energizing the wire adjacent to a particular needle, the desired letter could be so indicated. The theory was good, but the practice, as in the case of the Soemmering chemical telegraph, never became practical because of the complexity of wires.

Gian Domenico Romagnosi, jurist and physicist, performed an experiment with a voltaic cell and magnetic compass. His work, if continued, might have led to the discovery of electromagnetism.

The first practical application of Oersted's discovery was made by Johann S. C. Schweigger, a chemist of Halle, who announced on September 16, 1820, his improvement of a galvanomagnetic indicator which he called a "multiplier." This consisted of a coil of insulated wire of several turns about a magnetic needle. It was found to indicate quantitatively the magnetic force generated by the amount of current flowing in the coil. Schweigger had also observed that the deflecting power on the needle was increased by increasing the number of turns. Dr. Thomas J. Seebeck (1770-1831) experimenting with this indicator (or galvanometer) came to the conclusion that the effective power of a current flowing in a coil was not directly dependent on the number of turns because increasing the number of turns increased the length, and therefore the resistance, of the wire and decreased the resulting conductive power. The first electrical measuring instrument, based on the new electromagnetic force, was thus created.

During 1820 Davy had noticed that iron filings had adhered to a current-carrying wire to form a mass of ten or twelve times the thickness of the conductor. The



Romagnosi's experiment with the influence of a voltaic pile on a magnetic needle was interpreted by Govi (1869) as an electrostatic rather than an electromagnetic effect.

same phenomenon was observed by Arago and Seebeck in differing forms, using filings, soft iron, and steel needles. They found that the soft iron ones were difficult to magnetize permanently but the steel ones retained their magnetism permanently.

ROMAGNOSI AND MOJON

As EARLY as 1774 the Academy of Bavaria had offered a prize for the best dissertation in answer to the question "Is there a real and physical analogy between electric and magnetic forces?" Prof. J. H. van Swinden of Holland replied, in conclusion, that the similarities were entirely superficial and that the two forces were essentially of different kinds. A contrary position was taken by Professors Steighlehner and Hubner in 1773 and 1780 that such related forces must have their origin in a single agent. The full resolution of the question continues into our own time.

Two years after the voltaic pile had been announced, there appeared a letter in the *Gazzetta di Trento*, Italy, on August 3, 1802, in which Gian Domenico Romagnosi (1761-1835) a local jurist and amateur physicist of Trento and the university at Parma, described an electrical experiment that he had performed. Romagnosi's account, in translation, read:

"The Counsellor, Gian Domenico de Romagnosi of this city, known to the republic of letters by his learned productions, hastens to communicate to the physicists of Europe an experiment showing the action of the galvanic fluid on magnetism.

"Having constructed a voltaic pile, of thin discs of copper and zinc, separated by flannel soaked in a solution of sal-ammoniac, he attached to one of the poles one end of a silver chain, the other end of which passed through a short glass tube, and terminated in a silver knob. This being done, he took an ordinary compass-box, placed it on a glass stand, removed its glass cover, and touched one end of the needle with the silver knob, which he took care to hold by its glass envelope. After a few seconds' contact, the needle was observed to take up a new position, where it remained, even after the removal of the knob. A fresh application of the knob caused a still further deflection of the needle, which was always observed to remain in the position to which it was last deflected, as if its polarity were altogether destroyed.

"In order to restore this polarity, Romagnosi took the compass-box between his fingers and thumbs, and held it steadily for some seconds. The needle then returned to its original position, not all at once, but little by little, advancing like the minute or seconds hand of a clock.

"These experiments were made in the month of May, and repeated in the presence of a few spectators, when the effect was obtained without trouble and at a very sensible distance."

Romagnosi did not subsequently expand on the experiment nor draw any general conclusions from it, thus missing the chance of discovering electromagnetism. Benedetto Mojon of Genoa also reported an experiment in 1804 in which he placed steel needles in a circuit of a voltaic battery and let them remain there for many days. Mojon observed that the needles were magnetized when removed from the circuit. Like Romagnosi, Mojon did not expand on the experiment and also drew no basic conclusions. Romagnosi, who died in 1835, never claimed priority over Oersted in the 15 years subsequent to the announcement on electromagnetism in 1820 by the latter.

Obscure as the Romagnosi notice in the *Gazzetta* was, it was shortly picked up and repeated in two books by authors of considerable prominence. In 1804 Giovanni Aldini (1762-1834), a nephew of Galvani, published a large quarto of nearly 400 pages (dedicated to Napoleon) in which, on page 191, he alluded to the supposed magnetic influence of a galvanic circuit by stating, "This new property of galvanism has been confirmed by M. Romanesi, a physicist of Trent, who has observed that galvanism produces a declination of the magnetic needle."

On page 338 of Aldini's book an addendum of two and a half pages reviewed the relationship of electricity and magnetism which, he then pointed out, one already knew. The beautiful experiments of d'AEpinus, van Swinden, Cavallo, and Coulomb proved the close connection that existed between the two fluids. Lightning in striking a ship had been known to change the magnetic poles of the compass, which demonstrated the influence of electricity on magnetism. "I have believed it expedient to expose this last principle to the action of Galvanic apparatus," promised Aldini. He then described how he used a pile of 40 disks of copper and an equal number of zinc, each being 3 inches in diameter but having a central hole 1½ inches in diameter so as to form a pile that had a hollow core. Into this he could insert steel needles to see if they could become magnetized, or to change the polarity of other

needles already magnetized. But results were so weak that he did not dare draw a single decisive conclusion from them. They were a little more satisfactory when he left the needles exposed for a very long time to the current of a strong pile. Oxidation and the continued changing of soiled parts of the equipment prevented him from arriving at any definite conclusions. He then related how M. Mojon placed fine sewing needles 2 inches long horizontally between the terminals of a battery of a hundred cups where they remained for 20 days. These became oxidized but also magnetized with sensitive polarity. He then referred to the procedure of magnetizing by means of galvanism as had already been established by "Romanesi," who had caused a magnetic needle to decline by the application of current from a voltaic pile. Franklin had magnetized needles by using the discharge of four Leyden jars, as reported by Priestley in 1767.

The second popular work on galvanism was that of Prof. Joseph Izarn which also appeared in Paris in 1804. This included instructions given for magnetizing needles as proposed by Romagnosi of Trento and Mojon of Genoa. Under the headings *Preparation, Usage, and Effects*, the procedure was made clear. The third paragraph reads: "*Effects*—According to the observations of Romagnési, physicist of Trent, a needle already magnetized and which one thus submits to the galvanic current, shows a declination; and according to those of J. Mojon, a learned chemist of Genoa, the needles not magnetized acquire by this means a sort of magnetic polarity." This book was among those that were required, by order, to be placed in the library of every lycée in France.

A study was made by Dr. Joseph J. Hamel of St. Petersburg as to the failure of both Dr. Soemmering and Baron Schilling to take note of the description of Romagnosi's important discovery, as reported in the above two books. Dr. Hamel concluded that when Schilling returned to Munich in 1815, he communicated with Soemmering about the book by Izarn. Hamel also reported seeing a note from Soemmering indicating that he had read the treatise with attention. However, both investigators failed to grasp the practical implications of the note on Romagnosi and Mojon.

To some it appears that even the announcement of Oersted's discovery need not necessarily have led directly to the development of the electromagnet and electromagnetic telegraphy, for the contributions of Schweigger, Ampère, Arago, Sturgeon, Henry, and Morse seemed essential additional contributions. Dr. Hamel had added: "Hans Christian Oersted, at Copenhagen, had directed the attention of the scientific world, much more effectually than Romagnosi in Italy had done, to the fact that the magnetic needle deflects, when a galvanic current comes near it." The conclusion is therefore drawn that Romagnosi's observation was not thoroughly investigated, but was inadequately reported and made at a time when the world of science seemed unprepared to appreciate the vast significance of his observation or to apply it as was done immediately after the Oersted announcement. Like the parable of the seed, the one was an early sowing that fell upon a stony place, the other made in the full spring and falling on rich soil, took root and flowered. Oersted's love of the world of nature and his broad interests in science and philosophy tended to guide him to unifying forces and common laws binding related phenomena.

It must also be noted that a basic difference existed between a circuit similar to one constructed by Mojon in which an iron needle was inserted in the circuit and found to become magnetized, and that of Oersted, in which the needle was near, but not in the electric circuit. One (even if clearly understood) does not lead to the other. In fact, a contrary effect was reported by Oersted in his article on "Thermo-Electricity," mentioned previously, in which a Mr. Hill of Lund, Sweden, found that when a discharge passed *along* a magnetic needle, all its magnetism was destroyed. Oersted's was obviously an independent and basically different approach, one that led directly to the recognition and formulation of the laws of electromagnetism.

Hamel also examined the question of whether Oersted might already have known of Romagnosi's account. While it was true that Oersted had been in Paris in 1802 and 1803 and in contact with Aldini through correspondence, yet would he have waited 18 years to repeat the electromagnetic experiment, let alone expand on it, or chance someone else's announcement of so vital a combination? Besides, it is noted that Oersted's generous, open, and upright character must preclude any such deviousness, although Hamel did wish that, "on making known his own observations, he had just said a word about Romagnosi as pioneer in the field on which he became loaded with laurels." Hamel was indeed generous, but not as understanding as Govi. Dr. Hamel spoke with considerable authority because he was personally acquainted with Oersted, Schweig-

тело ток в землю, можно было объяснить этот опыт. Это и сделал соотечественник Романьози Зантедески в 1859 г., но, не

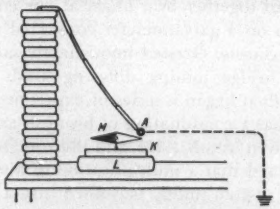
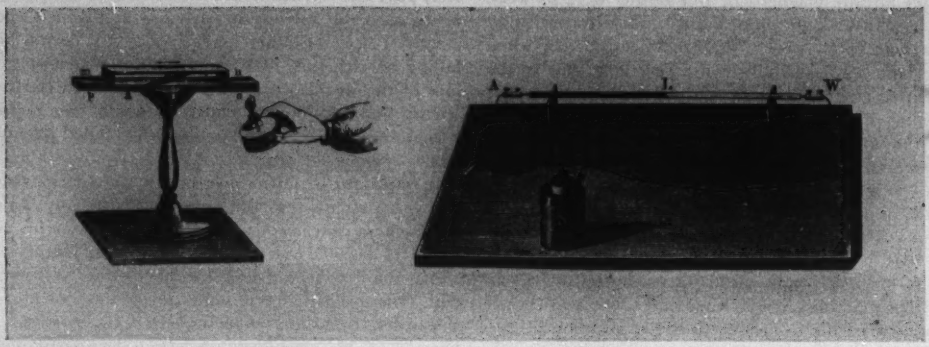


Рис. 1

ограничиваясь разъяснением приведенной нами заметки, он необоснованно выдвинул тезис о приоритете Романьози в открытии электромагнетизма и существования «открытых» токов, распространяющихся через Землю[9].

The continuing interest in the Romagnosi experiment is represented in a recent study of Prof. Olga Lezhneva of the USSR Academy of Sciences on the early history of electromagnetism. It is supposed that grounding through the experimenter's body might have completed the circuit and permitted the flow of enough current to affect the needle.



The Seebeck effect resulted when one end of a couple consisting of two joined dissimilar metals (here, bismuth and copper) was heated. An electric current, as manifested by the rotated needle, was generated. An opposite condition, the Peltier effect, was created when an electric current was passed through two joined, dissimilar metals (here, iron and copper) thereby warming the junction, or cooling it when the current flow was reversed. These discoveries of nearly a century ago are once again under investigation.

ger, Ampère, Arago, Soemmering, Schilling, and other founders of electromagnetic science and telegraphic practices.

APPLIED ELECTROMAGNETISM

SCHILLING reduced the telegraphic problem in 1823 to an installation in St. Petersburg of an electromagnetic telegraph apparatus employing five galvanometer needles, each having its own independent galvanic circuit. By introducing the ingenious expedient of causing each needle to move either positively or negatively, by resorting to a reversal of currents and combining two or more of the signals, a great simplification of the alphabet was possible. This apparatus was exhibited to the Emperor Alexander I shortly before his death in 1825.

In early February 1823, Oersted was in Paris where he spent much time with Ampère, Arago, Fresnel and Fourier. While there, announcement arrived of the discovery made by Seebeck of the Royal Academy in Berlin in which a plate of copper and one of bismuth, when pressed together by a finger at one end, produced a deflection on a galvanometer connected to the other end of the couple. Oersted immediately saw in this an additional bridge joining differing kinds of physical forces. He then began a series of experiments in which he found that a combination of bismuth and antimony gave improved results. He and Baron Fourier thereupon proposed that a multiplication of alternate strips of bismuth and antimony be joined into a ring so that heat could be applied at every second junction, leaving the first junction at room temperature; cooling the second with ice seemed to produce an even stronger electrical effect. Combining the heating at one end and cooling at the other caused the compass to deflect 60 degrees. This would parallel the assembly, and therefore the effects, of plates forming a voltaic pile. Oersted proposed the name "thermo-electric" for the currents so generated and published the results in a joint communication with Fourier in the *Annales de Chimie et Physique, vol.* XXII, Paris, 1823. Jean Peltier demonstrated in 1834 that the passage of an electric current through two joined dissimilar metals created or absorbed heat at the juncture, depending on the direction of current flow.

Oersted's contribution to the separation of aluminum was communicated in mid-February 1825 to the Royal Society of Sciences. In this he reported success in procuring a compound of chlorine and the combustible portion of alumina to which he had applied hydrogen. Over a mixture of carbon and pure alumina, which was heated to incandescence in a china tube, Oersted passed dry chlorine. Oxygen was emitted and aluminum chloride formed. This was quickly heated with potassium amalgam which decomposed into potassium chloride and aluminum amalgam. Distillation without admitting air produced metallic aluminum, a sample of which he showed in April to the Society of Sciences. A report on this appeared in Poggendorff's *Annalen der Physik*. In spite of this, credit for the initial production of aluminum is generally ascribed to Wöhler, whose paper was published in 1827. In this he indicated that he had read of Oersted's experiments, but the clearer account by Wöhler fixed the latter's method more definitely in men's minds.

(The concluding article of the series will appear in the September issue.)

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On Quantity Algebra and Rationalization

H. CASTELLIZ

An analysis of the fundamental concepts of the quantity calculus is attempted in order to answer the controversial question whether rationalization of electromagnetic equations is to be understood as a change of units or of quantities. It reveals that, from any point of view, the question can be answered only in the first sense.

THE recommendation of the International Electrotechnical Commission in 1950 to use the rationalized form of the electromagnetic equations has stimulated an extensive discussion on the subject of rationalization which, among other things, led to the question of whether rationalization is to be understood as a change of units or as a change of quantities. There appear to be two contradicting answers to this question, depending on the viewpoint. F. S. Silsbee[1,2] gave a clear picture of the situation and described the two aspects as the "classical" and the "modern" approach. However, it seems to the author that the apparent "paradox"[2] can be resolved by a careful analysis of the fundamentals.

The present study considers the process of devising a system of physical (or geometrical) equations and attempts to call attention to the critical steps. It uses very elementary geometrical examples for the purpose of illustration. The application to the actual problem is so obvious that it is treated in the summary.

We assume that all physical quantities under consideration lend themselves to linear measurements. This presupposes that it is possible to determine physically how often a sample A' of a quantity is "contained" in another sample A of the same kind ("dimension") or how many identical samples A' are to be combined to give the same effect as the sample A. The resulting pure number n can be called the "ratio" A/A' of the samples but this fraction means a *physical* operation (measurement) rather than a *mathematical* one. The symbols A and A' are understood to represent the actual samples (quantities) and are not numbers, nor do they have any reference to numbers or units, as yet.* In this sense only can the result of a measurement be expressed in an equation

$$\frac{A}{A'} = n \tag{1}$$

A special article recommended by the Applied Mathematics Subcommittee of the AIEE Basic Sciences Committee.

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*The same applies, in principle, to geometrical quantities, even though laws in geometry are not derived by physical measurement but by mathematical reasoning. Length, area, and volume have, a priori, nothing at all to do with numbers.

It is, therefore, a priori, not logically legitimate to combine quantities in mathematical equations in other ways than in fractions such as the above. A priori, there is no sense in multiplying, for instance, current into time, etc.; and no logical or mathematical consideration can prove that an area actually *is* the product of two lengths.

At this stage we are able to formulate the physical and geometrical laws merely in the form of proportions; for example, we state that the area of a rectangle is proportional to its length and its width, which we write

$$\frac{a}{a'} = \frac{x}{x'} \cdot \frac{y}{y'} \tag{2}$$

Here the symbols refer to the respective quantities of any two sample rectangles, say R and R'.

Obviously, equation 2 also applies to any other geometrical figure, e.g., to two triangles or to two ellipses, etc., whereby the symbols x, y, x', y' may refer to certain characteristic lengths of the figures. Of course, we can also establish the law that, for example, the areas of an ellipse and its circumscribed rectangle stand in the ratio of π:4.

The form of proportions would actually be sufficient to describe all geometrical and physical laws. It is, however, much more convenient to express them in the form of the conventional equations. To achieve this, it is necessary to refer all proportions in a given system to one general standard. This is the introduction of units. Two decisions have to be made: first, we select one type of figure (to continue our example of the geometrical system) as basic to our system; second, we select a certain sample of this type of figure as standard and define its characteristic lengths and its area as units. For this type of figure we can now write

$$\frac{a}{[a]} = \frac{x}{[x]} \cdot \frac{y}{[y]} \tag{3}$$

where the square brackets indicate the sample quantities selected as units.

We may call the chosen type of figure the "definitional figure" for the system. In physical applications we would rather refer to a "definitional phenomenon." (For instance, the phenomenon that a force acting upon a mass produces an acceleration in proportion to the former and to the inverse of the latter is a definitional phenomenon in the cgs and Giorgi system of mechanics.)

The special circumstances present in the one sample of the definitional phenomenon (or figure) which we use to define the units can be called "definitional circumstances." For example, the mass of 1 gram and the

acceleration of 1 cm/sec² are the definitional circumstances which define the unit of force in the cgs system. Units which are connected in this way so that they appear together as elements of a definitional phenomenon under the definitional circumstances are usually called "coherent" in the system determined by the definitional phenomenon.

If, as is customary, we choose as a definitional figure for Euclidean geometry, the rectangle and as characteristic lengths its sides, and if we define the unit length in either direction to be the same, we will say that a square of side unity has, per definition, the area unity. So we have

$$\frac{a}{[a]} = \frac{x}{[l]} \cdot \frac{y}{[l]} \quad \text{for rectangles} \tag{4}$$

For other figures we have now to introduce a numerical constant; e.g., we have to write

$$\frac{a}{[a]} = \frac{\pi}{4} \cdot \frac{x}{[l]} \cdot \frac{y}{[l]} \quad \text{for ellipses} \tag{5}$$

and so on.

Equations such as 4, 5, etc. are virtually "measure equations." The fractions $a/[a]$, $x/[l]$, etc., represent pure numbers and stand for the measure of the respective quantities. They may be replaced by symbols representing those measures, e.g., in the usual way

$$\frac{a}{[a]} = \{a\}, \frac{x}{[l]} = \{x\}, \text{ etc.} \tag{6}$$

(Here the "classicist"[1,2] is at his goal. He has derived his measure equations and a system of coherent units matching the equations. However, the "modernist" will carry on with us.)

It follows from the foregoing discussion that it would be, a priori, meaningless to develop equations such as 2, 3, 4, and 5 by multiplying the numerators and denominators. (And this is the reason why the "classicist" refuses to follow further.)

Nevertheless, one can *postulate* the right for such a procedure and *define* the meaning of the resulting products of quantities and units.*

The following two steps are necessary:

1. We postulate the quantity equation in principle. To this end, we define the meaning of the product of the numerators. In our example we define that the product length times length be an area.

2. We postulate that the quantity equations be of the same form as the corresponding measure equations with coherent units; that is to say, we require that the numerical factor should remain unchanged. To this end we define a unit equation in such a way that the denominators in equations 4 and 5 will cancel. This means we have to define the connection between units as a pure power product without numerical factor. In our case, we define

$$a = [l]^2 \tag{7}$$

Now we can proceed and substitute equation 7 into equations 4 and 5, and obtain the quantity equations

$$a = x \cdot y \quad \text{for the rectangle} \tag{8}$$

$$a = \frac{\pi}{4} xy \quad \text{for the ellipse} \tag{9}$$

and so on.

With the attainment of the quantity equations we have freed ourselves of the restriction to special units. However, the equations are not independent of the *system* used for their derivation, namely the definitional phenomena or figures. This fact requires attention.

We could have chosen as the definitional figure, with absolutely the same right, any other geometrical figure, e.g. (to deal with an instructive example noted by Silsbee[1]), the ellipse. This means we would have based our system on a unit of area equal to the area of a circle with diameter unity. These units, of course, would be equally coherent, within their system.

In this system the equations would read:

$$\frac{a}{[a]} = \frac{x}{[l]} \cdot \frac{y}{[l]} \quad \text{for the ellipse} \tag{4a}$$

$$\frac{a}{[a]} = \frac{4}{\pi} \cdot \frac{x}{[l]} \cdot \frac{y}{[l]} \quad \text{for the rectangle} \tag{5a}$$

The unit equation would again be

$$a = [l]^2 \tag{7a}$$

and the quantity equations, of the same form as the measure equations:

$$a = xy \quad \text{for the ellipse} \tag{8a}$$
$$a = x^2 \quad \text{for the circle}$$

$$a = \frac{4}{\pi} xy \quad \text{for the rectangle} \tag{9a}$$

and so on.

No difficulty would arise from the use of such a "nonrational" geometry. But if this system had been introduced in the early days of mathematics, we would read the symbol x^2 as "x circled" rather than as "x squared."

We see that the unit equation 7 or 7a, in itself does *not* include a definition of the actual magnitude of the derived unit. The symbol cm² does not say for how large an area it stands. This is determined solely by the choice of the definitional figure.

The "modernist," therefore, if he correctly understands his principles, will not conclude from the identity of the unit equation in both the rational and the nonrational system that the units are not affected by choice of the system. Nor will he proceed by combining equation 8 for a rectangle in the rational form (subscript r)

$$a_r = xy$$

*The mathematical legitimacy of such definitions has been treated by C. H. Page.[3]

and equation 9a for the same rectangle in the nonrational (n) form

$$a_n = \frac{4}{\pi} xy$$

concluding that, as x and y are the same in both cases

$$a_n = \frac{4}{\pi} a_r$$

which would mean that the quantities of area are different in the two cases. Such an argumentation would be erroneous because equations 8 and 9a belong to two different systems which are based on mutually exclusive definitions and are, therefore, incompatible. Consequently, these equations must not be combined. (After all, the rectangle has only one area and it seems neither necessary nor useful to define an "abstract" area which would depend on the way we make our measure system.)

This simple geometrical example was chosen because it is very illustrative. It showed precisely the points where, in the device of a system, voluntary decisions are necessary and possible. These very points have in the past often been overlooked,* and the decisions have been made instinctively. The systems in use became so deeply rooted that they seemed to be not merely the obvious but, in most cases, the only possible choice. The hidden problems did not become evident until, in the theory of electromagnetism, the classical systems proved impractical.

SUMMARY AND CONCLUSION

THE STEPS necessary to define a system of quantity equations and the derived coherent units may be summarized as follows:

1. Given are physical phenomena and laws which we can mathematically describe by proportions where the symbols stand for quantities and the fractions represent measurements. For example,

a. A current i_c in a long cylindrical coil produces a magnetic field H_c in proportion to the current and inverse to the spacing s of the turns:

$$\frac{H_c}{H_{c'}} = \frac{i_c}{i_{c'}} \Big/ \frac{s}{s'}$$

b. A current in a circular arc produces, in the center of the arc, a magnetic field in proportion to the current, to the angle of the arc φ and inverse to the radius, r:

$$\frac{H_a}{H_{a'}} = \frac{i_a}{i_{a'}} \cdot \frac{\varphi}{\varphi'} \Big/ \frac{r}{r'}$$

(Symbols with and without "prime" refer to any two samples of the same phenomenon, in each case. Subscripts c and a refer to coil and arc, respectively.)

2. The introduction of standards (units) by

a. Choice of certain phenomena or configurations out of the system of laws as *definitional* phenomena or configurations. These must be independent and their number is determined by the number of derived units to be defined. For example, for the definition of the unit of magnetic field strength, the rational system chooses the law 1a in the preceding section, the nonrational one the law 1b. Because these laws are not independent, the two choices exclude one another.

b. Choice of a certain sample of each definitional phenomenon as definitional circumstances and definition of the quantities there present as units. For example, in the rational system: "The unit of field strength is present in a long coil of pitch 1 meter when carrying a current of 1 ampere." In the nonrational system: "The unit of field strength is present in the center of an arc of 1 radian and 1 meter radius, carrying a current of 1 ampere."

3. Rewriting the system of proportions in terms of these units leads to the system of measure equations.

For the rational system,

$$\frac{H_c}{[H]_r} = \frac{i_c}{\text{amp}} \Big/ \frac{s}{\text{meter}}; \quad \frac{H_a}{[H]_r} = \frac{1}{4\pi} \frac{i_a}{\text{amp}} \frac{\varphi}{\text{radian}} \Big/ \frac{r}{\text{meter}}$$

For the nonrational system,

$$\frac{H_a}{[H]_n} = \frac{i_a}{\text{amp}} \frac{\varphi}{\text{radian}} \Big/ \frac{r}{\text{meter}}; \quad \frac{H_c}{[H]_n} = 4\pi \frac{i_c}{\text{amp}} \Big/ \frac{s}{\text{meter}} \; *$$

(Subscripts r and n indicate rational and nonrational, respectively. The denominators may be omitted if the symbols in the numerators are understood to mean measures rather than quantities. This leads to the conventional form of the measure equation with coherent units.)

4. The postulate of the quantity equation and the introduction of definitions as required:

a. Definition of the meaning of the power product of quantities as required by the respective equations; e.g., "The quotient current over length is per definition a magnetic field strength."

b. Definition of the derived unit as a pure power product of basic or previously defined units, according to 4a, without numerical factor; e.g.,

For the rational system,

$$[H]_r = \text{amp/meter}$$

For the nonrational system,

$$[H]_n = \text{amp/meter}$$

The result is the quantity equation of identical form with the measure equation in step 3; i.e.,
Rational:

$$H_c = \frac{i_c}{s}; \quad H_a = \frac{1}{4\pi} \cdot \frac{i_a \varphi}{r}$$

*There are even "proofs" in the literature[4] that coherent units can only be defined in Cartesian co-ordinates and rational systems.

*Equations written in this manner were, to the author's knowledge, first introduced by J. Wallot.[5]

Nonrational:

$$H_a = \frac{i_a \varphi}{r}; \quad H_c = 4\pi \frac{i_c}{s}$$

It has been shown that emphasis is necessary in step 2a because the choice it includes has not been adequately recognized in the past. It is this step which essentially determines the form of the system of equations and the magnitude of the derived units.

The unit symbol or "abstract" unit (e.g., amp/meter, step 4b) is virtually only a reference to the dimensional relation and to the fundamental units. It gives no indication of the magnitude of the unit, unless the system is specified by 2a.

It is concluded that from both the classical and the quantity algebra viewpoint, only units are affected by rationalization and not quantities.

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A New Kind of Tachometer

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The simple speed-indicating device described possesses low inertia, low friction, no residual output at zero speed, and a d-c output voltage precisely proportional to speed. Although this tachometer is still in the prototype stage, it is anticipated that an instrument can be produced which would be superior to the types now available.

THE TACHOMETER, or swiftness meter, is one of the most important control system components. This fact has resulted in a great amount of effort to find the ideal device. Evidently these efforts have not been wholly successful, for, in spite of the fact that many types of tachometers are available,[1] the most used devices continue to be those whose development took very little ingenuity; i.e., miniature d-c generators, a-c induction generators, and pulse counters. This is probably true because all the more ingenious tachometers that have been developed have brought with them major disadvantages when considered for general application. Furthermore, one should not think that the miniature generators or the pulse counters are without defects. For example, the output voltage of the d-c rate generator contains a low-frequency ripple voltage caused by rectification of the voltage by means of commutator bars and brushes. Also, brush jump at high velocities causes spurious voltages. The main disadvantages, however, are that the brushes produce friction of the order of 1 ounce-inch and that the rotor has relatively high inertia.[2]

The a-c drag cup induction generator eliminates the disadvantages of brush friction and high inertia but suffers from others. Among these are that the output voltage contains third and fifth harmonic components caused by the nonlinearity of the magnetic circuit and, more important, that the output voltage is not zero when the speed of the shaft is zero.[3] Besides being a function of speed, the output of the drag cup generator is also a function of the voltage applied to the primary winding. Whereas this is not a disadvantage in the usual sense, it does require careful regulation of the applied voltage. Furthermore, the fact that the output is an a-c voltage (as opposed to d-c produced by the first device described) can cause additional components to be used and time delays to occur in certain applications.

Perhaps the most versatile tachometer is the pulse-counting type. It can be made to operate from light pulses reflected from white marks on the rotating shaft whose speed is to be measured and, in that manner, contribute zero inertia to the rotating system. Other designs use slits in a thin disk to pass a number of light pulses proportional to speed. Still others use changes in reluctance caused by teeth of a ferromagnetic disk to produce a variation proportional to speed. No matter what technique is used to develop the pulse train, however, all these devices have the disadvantage of requiring an appreciable amount of additional circuitry if the device is made to interpret the frequency-modulated pulse

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A patent application has been filed on the subject tachometer.

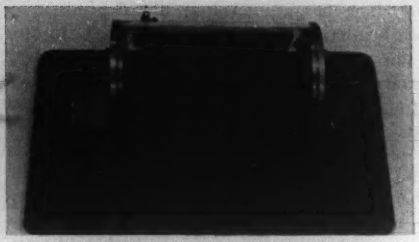

Fig. 1 (*left*). Tachometer.

Fig. 2 (*right*). Combs and rotor.

train as a voltage whose magnitude is a function of speed. An example of the high accuracy obtainable from a pulse-counting tachometer and the size of a production-type unit can be obtained from reference 4. This type has been described[1] as relatively expensive compared to others.

The brief survey of existing tachometers just given above indicates the need for a simple device which has low friction, low inertia, fast electrical response, no residual output, and d-c output. Such a device was developed recently. It is the purpose of this article, therefore, to describe this new tachometer and its characteristics, and to suggest tooled-production embodiments.

DESCRIPTION

THE PROTOTYPE MODEL of this new tachometer is a simple device, as shown by Fig. 1. The important parts are merely two electrodes and an insulated rotor, as shown in Fig. 2. These electrodes or combs are composed of two rows of steel phonograph needles on $\frac{3}{32}$-inch centers. The needles of one row are placed $\frac{3}{64}$ inch from the in-line position with the second row. Made in this way, the two rows present a total of 58 sharp points on $\frac{3}{64}$-inch centers to an area moved perpendicular to the rows. The purpose of these points is to provide a high-voltage gradient whereby electrons are drawn from one electrode to the rotor by high field emission. The air gaps in the model constructed are $\frac{1}{16}$ inch. A shorter gap is preferred, but the difficulty encountered in controlling the position of the needles made it necessary to use the longer gap to mask the variations of this model. Of course the longer air gaps increased the voltage required to produce the high field emission over the voltage necessary in a more accurately made model. A voltage of 6,000 volts was used in the first model. This does not defeat the purpose of the prototype, however, since it was constructed only to test the principles involved and supply data for further development.

Because this tachometer requires that its rotating element be connected to the device whose speed is being measured (as do all others except the pulse-counting type), one of the desirable characteristics sought was that of low rotor inertia. For this reason rotors were constructed in two different ways. In one embodiment the rotor is a hollow aluminum cylinder wrapped with self-adhering silicon tape and then coated with Formvar. This construction made possible the model shop manufacture of a device with reasonable tolerances and reliable operation. Conceivably, however, even lower inertia could be obtained by relying upon the insulation for mechanical strength and using a conducting surface much thinner than one could possibly machine. To prove that this type of construction offers no inherent difficulties, another rotor was made of glass tubing coated on the inside surface with silver conducting paint. Successful operation was obtained from both embodiments. However test results are presented here only for the silicon-insulated rotor.

In operation, a d-c voltage sufficient to cause high field emission is placed between electrodes. Electrons leave the negative electrode and are drawn toward the insulated rotor. Since these electrons are trapped on the outer surface of the insulation, they tend to prevent other electrons from leaving the electrode points. In fact, if the rotor is stationary, this initial flow of charges quickly reduces to zero and the device acts as a very small (approximately 20-μμf) capacitor.

If the rotor is now made to turn, the area covered with electrons moves away from the negative electrode and other electrons are emitted to flow to the new uncharged areas of the rotor as they pass under the electrode points. This action would stop after one revolution except for the second electrode which is at a positive potential with respect to the rotor. This electrode attracts the electrons and, in effect, wipes the rotor clean. The electrons are thereby returned to the positive terminal of the d-c supply. A resistor is placed in this simple series circuit, and the rate of flow of electrons is measured by a suitable voltage-measuring device connected across the resistor. The current passed by the model is of the order of 0 to 25 microamperes. Thus the output voltage must be applied to a d-c vacuum-tube voltmeter for measurement or to a suitable amplifier if the device is a part of a control system. It also is necessary to place a capacitor across the resistor if the output is to be displayed on an oscilloscope. The reason for this will be discussed later. The circuit diagram of the basic unit is shown in Fig. 3.

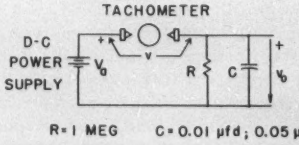

Fig. 3. Tachometer circuit.

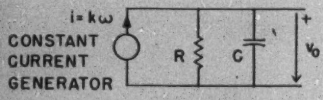

Fig. 4. Equivalent circuit for constant anode - to - cathode voltage.

MATHEMATICAL ANALYSIS

IT IS USUAL for any new device to be preceded by other related devices. This tachometer, for example, bears some resemblance to a miniature Van de Graaff generator. There are important differences, however, in both the electric circuit and the structure of these devices. It is these differences which make this device valuable as a tachometer because, whereas the van de Graaff generator has short-circuit current which is not linear with speed,[5] it will be shown that this device has the necessary linear characteristic.

Perhaps the best way to describe the device in terms of elements already familiar to the reader is to say that it is a diode wherein the plate current is inhibited by the insulated member placed between the anode and cathode. More specifically, if one assumes that the time required to saturate a section of the cylinder with charge is negligible compared to the time necessary to remove the section from the influence of the combs, then the charge per unit area will be a function of voltage and spacing; that is,

$$\frac{dq}{dA} = f(v, l)$$

where dA is the differential area charged, v is the voltage between anode and cathode and l is a characteristic distance. But

$$i = \frac{dq}{dt} = \frac{dq}{dA}\frac{dA}{dt} \text{ and } dA = ar\,d\theta$$

if r is the outer radius of the rotor, and a is the axial length. This gives

$$i = f(v, l)\, ar \frac{d\theta}{dt} = [f(v, l)\, ar]\,\omega \qquad (1)$$

Equation 1 shows that for constant anode-to-cathode voltage a given tachometer acts as a current generator the output of which is directly proportional to angular speed ω. The calibration curves corroborate this conclusion. Thus one may refer to the circuit of Fig. 4 as the equivalent circuit.

CALIBRATION

THIS DEVICE was calibrated by means of a mechanical tachometer as a standard. Curves of voltage developed across the output resistor of the tachometer as measured by a vacuum-tube voltmeter vs. speed in rpm are shown for the silicon-insulated rotor in Fig. 5. The important information obtained from this graph is the perfect linearity of the output voltage with respect to the speed, the fact that zero output voltage is obtained at zero speed, and the acceptable value of sensitivity of approximately 1½ volts per 100 rpm.

The fact that the output voltage also depends upon the applied voltage is shown by equation 1. In this respect, this tachometer is not different from the drag cup generator, which requires that the voltage applied to its primary winding be maintained constant. Data were taken to show how the output voltage varies with applied voltage at a given speed. The results are shown in Fig. 6. The section of the curves from 0 to 4,200 volts, where no output occurs, corresponds to that condition of operation wherein the applied voltage is not sufficient to produce charge carriers by high field emission. With the gap dimensions used, electrons are drawn from the negative comb and are pulled to the rotor when the voltage exceeds 4,200 volts. As the voltage is increased under this condition, the current increases rapidly at first and then less rapidly. The curves of Fig. 6 justify the comparison of the tachometer to a diode as mentioned previously. If one compares the output voltage, applied voltage, and angular velocity of the tachometer, respectively, to the plate current, filament voltage, and plate voltage of the diode, the analogy is evident. For this reason the new tachometer will be referred to as a diode tachometer to give it a concise descriptive name.

The variation of output voltage with moisture content of the air was also studied over a period of several weeks by recording the output voltage for an input of 6,000 volts and a speed of 1,800 rpm during each day. Humidity and moisture content of the ambient air were determined before each reading by using a sling psychrometer. The tests show that the output voltage decreases about 8% with a 100% increase in moisture content of the air.

TRANSIENT RESPONSE

IT HAS BEEN STATED that a capacitor is used across the output resistor of the tachometer. This is not necessary if an averaging device such as a vacuum-tube voltmeter is used to indicate steady-state speed. If transient response is desired, however, one finds that the output of the tachometer contains a large noise component. A typical output characteristic without a bypass capacitor is shown in Fig. 7. Here the oscilloscope amplification was reduced to such an extent that the small step on the left side of the trace represents 25 volts. The reduction of amplification was necessary to permit identification of the trace. With greater amplification the noise-filled trace merely fades into the background illumination of the oscilloscope screen.

The bypass capacitor effectively removes the high-

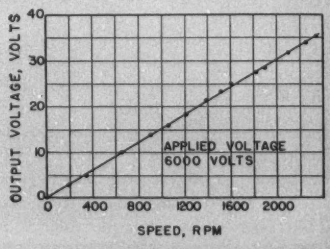

Fig. 5. Tachometer calibration (silicon rotor).

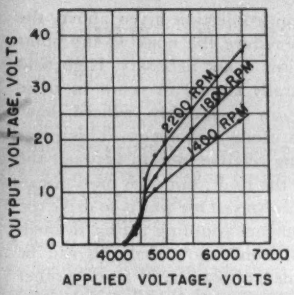

Fig. 6. Tachometer output vs. applied voltage.

Fig. 7. Unfiltered tachometer output.

frequency noise from the output. However, since the capacitor also provides a circuit having a time constant which limits the speed of response of the tachometer, it was selected with as low a value of capacitance as could be used consistent with reduction of the noise to a suitable level.

In an effort to get a fast change in angular velocity, a small d-c motor was loaded only by the tachometer and started suddenly on full voltage. The response of the tachometer was compared to the speed indicated by pulses of light reflected from eight white sections painted on a black plastic disk which was attached to the shaft of the tachometer. The results are shown in Figs. 8 and 9 for two values of bypass capacitors (approximately 0.01 and 0.06 μf). In each set of curves *i* is a 60-cycle timing wave, curve *ii* is the output of the tachometer, and curve *iii* is the output of the light pulse meter. The data obtainable from Figs. 8 and 9 are plotted in Fig. 10. These curves show that the tachometer with the *R-C* load shown in Fig. 3 does not respond instantaneously to speed changes and, as would be anticipated, the larger the bypass capacitor the longer the delay in reaching a new steady-state value. Conversely, any improved design which would reduce the noise content of the output to permit a smaller bypass capacitor would result in quicker response. Ideally, one seeks to reduce the noise to such an extent that the bypass capacitor is not necessary. Such improvement will be suggested later.

Actually the diode tachometer compares more favorably with the light-pulse meter than is shown by the curves of Fig. 10. The speed indication of the light-pulse meter was determined by using the time for one cycle of the frequency-modulated wave and assigning the speed value thereby obtained to a time corresponding to the midpoint of that pulse. Thus, information was used from the light-pulse trace $\frac{1}{16}$ revolution later than the information used from the diode tachometer trace. Furthermore, one should realize that the pulse-counting or demodulating circuit that would be necessary to display the output of the light-pulse meter as a voltage of varying amplitude would result in time delay that did not occur by the method used here. In other words, the curve marked light indicator in Fig. 10 should be as the instantaneous speed and not as the output displayed by any physically realizable system.

Some insight into the significance of the curves of Fig. 10 can be gained by investigating the response of the equivalent circuit of Fig. 4 when the speed is assumed to change as a ramp function from 0 to 1,800 rpm in 0.055 second. This is close to the variation shown by the light indicator curve of Fig. 10. The Laplace transform of the output voltage of Fig. 4 for ramp input is

$$V_o(s) = \frac{K/C}{s^2\left(\frac{1}{RC}+s\right)}$$

and the time domain solution is

$$v_o(t) = KR^2C\left(\epsilon^{-\frac{t}{RC}}+\frac{t}{RC}-1\right) \qquad (2)$$

Voltage $v_o(t)$ was computed for R of 1 megohm and C of 0.01 and 0.06 μf. The results, interpreted as speed by using the calibration curves, are shown by dashed lines on Fig. 10. The only significant difference between ideal and experimental curves is that the experimental curve for the 0.06-μf bypass capacitor shows less delay than the corresponding ideal curve, probably because the speed variation from the experimental case is not truly a ramp function. In any event, these curves show that time delays are not caused by the action of the

Fig. 8. Tachometer indication of starting motor (0.01 μf).

Fig. 9. Tachometer indication of starting motor (0.06 μf).

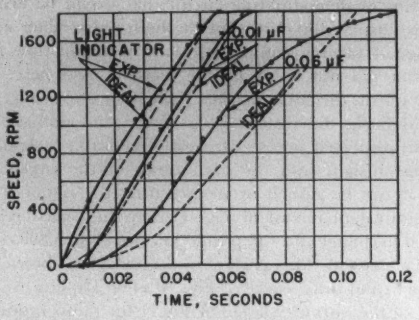

Fig. 10. Comparison of tachometer and light-pulse indicator with starting motor.

diode tachometer, but by the bypass capacitor. Thus, the equivalent circuit of Fig. 4 is justified for transient response as well as steady-state operation. The fact that this device is a constant-current generator with an output proportional to speed for constant anode-to-cathode voltage has been shown.

SUGGESTED IMPROVEMENTS

ALTHOUGH it has already been demonstrated that the diode tachometer has many desirable characteristics, there are certain objections which must be considered. Among these are:

1. It requires a relatively high voltage between anode and cathode.
2. It experiences a time delay in transient response due to the noise-filtering capacitor.
3. Its output decreases with an increase in moisture content of the air.

With some thought one can find likely solutions to these problems. For example, recent research[6] in high field emission indicates that reasonable current and electrode voltage (320 volts) are possible with accurately made tungsten needlepoints. Also, the use of thermionic emission would reduce the voltage requirement to only that necessary to attract the free electrons to the anode plus the drop across the output resistor. Furthermore, with thermionic emission one would expect the output voltage to be less sensitive to the applied voltage, as the device could then operate under space charge conditions.

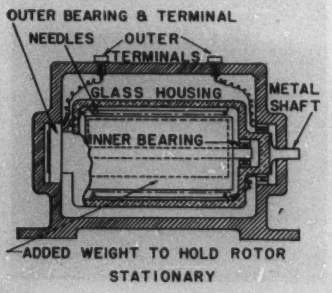

Fig. 11. Evacuated tachometer with rotating combs.

In regard to the second objection given above, the solution is obviously to reduce the noise to the point where the bypass capacitor is not necessary. High field emission in gas is generally known to result in noise generation. This noise can be suitably reduced, however, by evacuating the diode tachometer. This poses the problem of obtaining relative motion between the anode and cathode and the rotor, but such motion can be provided in at least two ways. One way is to drive the rotor by a permanent-magnet coupling acting through a glass envelope. Calculations[7] show that this can be done with ceramic magnets of reasonable size. Another way of providing this necessary relative motion is to use a double set of bearings which would permit the inner cylinder to be held stationary by an eccentric weight or a holding magnet while the housing rotates and carries the combs around the cylinder. The combs could be electrically connected to a stationary outer housing through the bearings, as shown in Fig. 11, to provide a device of relatively low friction and inertia.

The solution offered to the second objection would also eliminate the third objection. Thus, one can visualize the final diode tachometer as an evacuated device using the latest techniques of high field emission or thermionic emission and driven by magnetic coupling or using a double set of bearings. Unfortunately, this device was developed by individual effort and such a sophisticated embodiment is not attainable under these conditions.

CONCLUSIONS

THE SPEED-INDICATING DEVICE described is simple in construction and has the desirable characteristics of low inertia, low friction, no residual output at zero speed, and a d-c output voltage precisely proportional to speed. The equivalent circuit of the diode tachometer was shown to be consistent with steady-state and transient operation of the device. Furthermore, although the prototype model possessed some time delay, it was proved that the delay was caused by the noise-filtering capacitor and not by any effect inherent to the principle of operation. It was suggested that the noise and the filtering capacitor can be eliminated by evacuating the device. Thus, the diode tachometer seems to have combined all the desirable characteristics of the other tachometers and it is anticipated that an instrument can be produced based upon the prototype model which would be superior to any now available.

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Limits of Distribution Feeder Voltage Regulation

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THE DELIVERY of required voltage to the feeding point of distribution feeders, as limited by the circuit and load parameters, is the subject of this study. For this it is necessary to relate the simultaneous interactions of the following variables: station bus voltage, feeder load, feeder voltage drop, and voltage regulator range. The physical sequence of the essential components of a single-phase feeder is shown in Fig. 1.

The vector relations of the load current I, bus voltage V_B, input and output of the regulator, NB and NA, respectively, primary relay setting V_R, "effective" reactor drop ZI, regulator boost BA, "effective" feeder drop F, and overcompensation O, are shown in Fig. 2.

Incidentally, Fig. 2 represents the two equal and opposite voltage rises: (1) from the substation neutral bus ground N to the regulator output terminal A; and (2) from the first (feeding point) transformer primary neutral ground N to the regulator output terminal A. It is the basis of the following general equation:

$$(1 + p)\,(V_B - kZI) = V_R + k\,(F + O) \qquad (1)$$

where p is the per-unit plus or minus regulator range and k is the ratio of the current in the circuit at any time to the circuit peak load.

Since in circuit voltage regulation the prime concern is the magnitude of the voltage vectors, regardless of their angular displacement, use of complex number operations have been obviated, at little sacrifice in accuracy, by the use of the "effective impedance drop" form:

$$ZI = I\,(R \cos\theta + X \sin\theta)$$

This is linearly subtractive from the originating or additive to the resultant voltage vectors, $V_B - ZI$ and $V_R + (O + F)$ in Fig. 2.

Solving equation 1 for bus voltage:

$$V_B = \frac{V_R + k\,[F + O + (1 + p)\,ZI]}{1 + p} \qquad (2)$$

Also solving equation 1 for feeder drop:

$$F = \frac{(1 + p)\,(V_B - kZI) - V_R}{k} - O \qquad (3)$$

Equation 2 may be used to determine whether the permissible upper and lower voltage limits of a group of circuits encompass the voltage range of the bus serving them; and, if not, the corrective measures required.

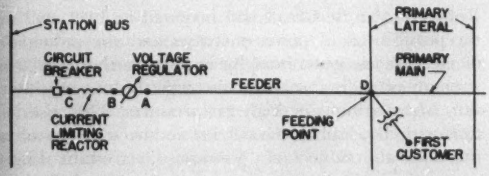


Fig. 1. Diagram of single-phase primary feeder, indicating sequence of essential components. Points A, B, C, and D correspond to similarly marked points of Fig. 2.

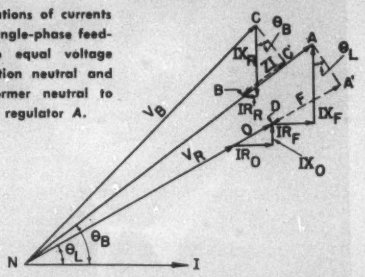


Fig. 2. Vector relations of currents and voltages on single-phase feeder, seen as two equal voltage rises from substation neutral and from first transformer neutral to output of voltage regulator A.

Equation 3 determines the maximum permissible voltage drop for new feeders in planning. Thus, at peak load ($k = 1$) and regulator at full boost $(1 + p)$, lowest permissible bus voltage V_L would be

$$V_L = \frac{V_R + F + O}{(1 + p)} + ZI \qquad (4)$$

and the maximum permissible feeder drop

$$F = (1 + p)\,(V_L - ZI) - (V_R + O) \qquad (5)$$

Also at light load, regulator at full buck $(1 - p)$, the highest permissible bus voltage is

$$V_H = \frac{V_R + k\,(F + O)}{(1 - p)} + kZI \qquad (6)$$

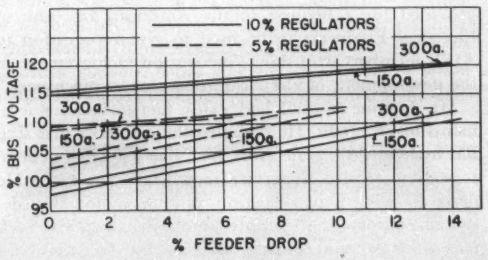


Fig. 3. Permissible bus voltage range, with station reactors.

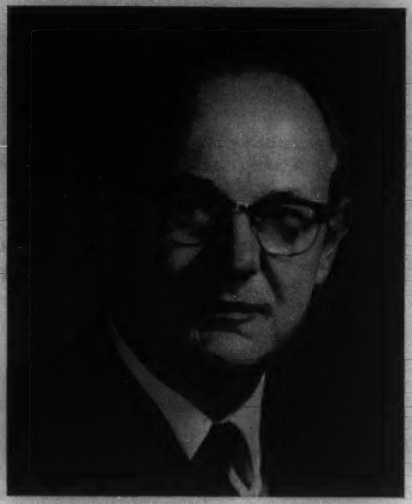
For any particular system, equations 4 and 6 may be accurately solved for each of a group of circuits. Considerable labor may be saved for an approximate first survey if limits of graphs similar to Fig. 3 are plotted for a group of circuits for which k and station power factor values are known to be approximately equal.

Digest of paper 60-855, "Correlation of Radial Distribution Feeder Regulation Variables and Determination of Regular Control Limits," recommended by the AIEE Transmission and Distribution Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Summer General Meeting, Atlantic City, N. J., June 19-24, 1960. Published in AIEE *Power Apparatus and Systems*, Dec. 1960, pp. 988-91.

C. J. Couy is with the Duquesne Light Company, McKeesport, Pa.

John G. Trump

1960 Lamme Medalist



History of the Medal

J. L. CANTWELL
FELLOW AIEE

IN AWARDING the Lamme Medal today, we honor not only the recipient, but also the memory of one of the pioneers of the electrical engineering profession —Benjamin Garver Lamme.

One of the early practitioners of perfection in the electrical design field, Mr. Lamme was an Ohio farm boy who rose through the profession to become chief engineer of Westinghouse. At his death in 1924, his will provided for a bequest to the American Institute of Electrical Engineers to be used to give recognition to AIEE members who show "meritorious achievement in the development of electrical apparatus or machinery."

Mr. Lamme himself had many meritorious achievements to his credit. He designed the country's first sizable hydroelectric generators for Niagara Falls—generators that are still in service today, 66 years later. He designed the single-reduction railway motor. He designed equipment to supply power for the New York City elevated and subway systems and for the New York, New Haven and Hartford Railroad.

Himself a recipient of the Edison Medal, Mr. Lamme was a brilliant design and development engineer. But his accomplishments did not end there. He combined a capacity for engineering achievement with an equally engaging concern for transmitting to his associates, particularly the younger engineers, his own confidence and vision.

Presentation and acceptance addresses given at the general session of the AIEE Summer General Meeting, Cornell University, Ithaca, N. Y., June 18-23, 1961.

J. L. Cantwell is with the General Electric Company, Pittsfield, Mass.

The author acknowledges his indebtedness to J. H. Chiles, Jr., chairman, Lamme Medal Committee, who furnished the information and many of the ideas upon which this address is based.

It is fitting that we pay tribute to the dedicated pioneers in our profession who have left such a proud heritage for us to build upon. Every profession, ours not excepted, has been lifted and advanced by the noble purposes and unselfish devotion of a few leaders.

We are fortunate in having had men who did not stop at personal accomplishments in the pursuit of their duties. We are fortunate in having had men whose vision encompassed not only what was at hand, but also the wide and distant horizon.

Such a man was Benjamin Garver Lamme, whose philosophy is well summarized by the inscription on the medal we are about to award. It reads: "The engineer views hopefully the hitherto unattainable."

Mr. Lamme did much to make the unattainable attainable. I am very pleased that the 1960 award—to Dr. John G. Trump—is being given to one who also "views hopefully the hitherto unattainable."

Career of the Medalist

H. R. STEWART
FELLOW AIEE

IT IS an honor and privilege to have been given the opportunity to outline the career of one who has earned the distinction of being awarded the Lamme Medal.

Dr. Trump was born in New York City and received the first part of his engineering education at the Brooklyn Polytechnic Institute where he received the degree of Electrical Engineer in 1929. For the next two years he continued as an instructor in electrical engineering at the same institution while pursuing studies in physics at Columbia University where he secured his M.A. degree in physics in 1931. He then came to the Massachusetts Institute of Technology (MIT) to study for his doctorate. It was there that he became greatly interested in the electrostatic belt generator, which Robert J. Van de Graaff had invented in 1930, and in the possibilities of power increases and size reduction of electrostatic generators by improving the dielectric strength of their insulation through the use of either very high vacuums or high gas pressures. This association with Dr. Van de Graaff led to the selection of a thesis on the subject of "Vacuum Electrostatic Engineering" which was a study of factors which influence the voltage-insulation strength between electrodes in high vacuum.

After securing his D.Sc. in E.E. in 1933, Dr. Trump continued as a research associate at MIT, studying particularly the feasibility of vacuum-insulated rotating electrostatic power machinery. The study of high d-c voltages applied to vacuum gaps led to medical applications of the Van de Graaff generator. In the Fall of 1935, the development of an air-insulated million-volt electrostatic generator and X-ray tube was undertaken for the Huntington Memorial Hospital in Boston for treatment of cancer. This work was done in conjunction with the Harvard Medical School. The first cancer patient was treated in March 1937. Subsequently, with his associates at MIT, studies were made of the insulating properties of compressed gases and of methods of controlling the electric fields in a pressure-insulated Van de Graaff generator. This led to the development of a far more compact 1.25-million-volt X-ray source for the Masachusetts General Hospital. This penetrating X-ray source was first used clinically in the Spring of 1940 and remained in active use for therapy for over 15 years.

After the outbreak of World War II, Dr. Trump's efforts were diverted in 1940 to national defense work under the auspices of the National Defense Research Committee (NDRC) in radio and radar activity. From 1942 to 1944 he was secretary of the Microwave Committee of NDRC and later an associate director of MIT's Radiation Laboratory. In 1944, he was sent to England to be the director of the British branch of the Radiation Laboratory until May 1945. During this period the laboratory played an active part in introducing microwave radar both for the tactical and strategic aerial offense against Germany and in the defense of Britain against aerial bombing and the V-1's. He was also consultant on radar to General Carl Spatz, Commanding General of the U. S. Air Force in Europe. For these war services he received His Majesty's Medal and a Presidential Citation.

After returning to the United States, Dr. Trump resumed his work in MIT's High Voltage Research Laboratory. He was promoted to the rank of Associate Professor of Electrical Engineering at MIT and in 1952 became a full professor.

In the meantime he cofounded in 1946 the High Voltage Engineering Corporation with Dr. Van de Graaff and Dr. Denis M. Robinson with whom a friendship had developed during Dr. Trump's British tour of duty. From the outset, Dr. Trump has been chairman of the Board of Directors and technical director of this corporation. This company manufactures particle accelerators for nuclear research organizations and for medical research all over the world. The energy stability of the accelerated particles from these constant-potential accelerators is almost unbelievably uniform, such particle accelerators being indispensable for precise studies of the energy levels within atomic nuclei. A visit to the manufacturing plant on Boston's famous Route 128 gives one a startling picture of the breadth of this activity when the destinations of the generators under construction are noted. More than 250 machines have been distributed to the United States and 20 other countries.

In parallel with the product development and manufacturing activity at High Voltage Engineering Corporation, MIT's High Voltage Research Laboratory emphasizes medical applications of high energy X rays and electrons. These investigations include actual clinical treatment in collaboration with medical doctors from the Lahey Clinic. In addition, research continues on the dielectric properties of insulating materials under high d-c stress and on the dielectric behavior of high vacuum.

During the course of Dr. Trump's research and development work on particle accelerators and X-ray techniques and their medical applications, he has been author or co-author of over 50 technical papers, many of them in such journals as AIEE *Transactions, Journal of Applied Physics, Journal of the American Medical Association,* and *American Journal of Roentgenology*. He is also the holder of more than 10 patents.

He is a Fellow of the AIEE, a Fellow of the American Physical Society, and a member of the American Academy of Arts and Sciences, American Nuclear Society, American Radium Society, and several other professional and scientific organizations.

All of the foregoing lists our Medalist's distinguished technical and organizational achievements. We like to think that they do not require a machine-like man for their attainment but that they are possible to a man of personal warmth, modesty, patience, and high integrity, such as Dr. Trump, whom I have known for almost 30 years. Associates who have known him equally long or who work with him every day either in the electrical or medical fields have said: "Apart from his technical achievements, John Trump is endowed with the finest qualities that one could seek in a leader and a fellow man. His kind and humane attitude toward his asso-

"For meritorious achievement in the design of particle accelerators and X-ray generators; more specifically for invention and design related both to multi-electrode acceleration tubes and to Van de Graaff generators; and also for exceptional contributions which led to applications in treatment of malignant diseases."

H. R. Stewart is with the New England Electric System, Boston, Mass.

ciates, his eager and selfless desire to advance his coworkers, and his impartial and objective judgment make it a real pleasure to be working under his direction"; and "He has found time to remain faithful to his original goals in the treatment of malignant diseases by supervoltage X rays and electrons. He is accepted by the top radiologists in this country as an expert with them in supervoltage therapy, and is their trusted confidant, consultant, and advisor."

The development of these qualities has been favored by a sympathetic family environment where Mrs. Trump, a son just out of college, a daughter in college, and a daughter about to enter college, have doubtless contributed in their respective ways to the building of this "whole man."

The sum of all these attributes has made it a very gratifying task to prepare this introduction, and they inspire all the Medalist's friends and associates—together with the more than 75 research students he has trained—to congratulate him on this award and to wish him well in his further career.

Response of the Medalist

J. G. TRUMP
FELLOW AIEE

IN ACCEPTING this fine gold medal commemorating a distinguished electrical engineer, Benjamin G. Lamme, I am gratefully aware both of the fortunate circumstances which time and again led me down an interesting trail of professional effort and of my enormous indebtedness to others—my associates, teachers, and students at Brooklyn Polytechnic Institute, Columbia, and especially MIT, where I have been privileged to work for nearly 30 years. I am indebted, as well, to a vast historical background of science and engineering, sparkling with such names as Thales of Miletus, Von Guericke, Faraday, and Roentgen.

For me, one of the determining influences in my career came near the start of my MIT studies as a suggestion of Vannevar Bush, then dean of engineering, and since a Lamme medalist himself. In search of a suitable doctorate problem, Dr. Bush suggested that I look up nuclear physicist Van de Graaff who, with some remarkable ideas on the electrostatic generation of high, constant voltages for the assault on the atomic nucleus, had followed MIT's new president, Karl Taylor Compton, from Princeton to Cambridge. Having conjured an image of an elderly Dutch professor, I was surprised the next morning to find Robert Van de Graaff barely a few years older than myself, and speaking with a soft Alabama accent.

Thus began a friendship which continues happily to this day and which directed my interest toward high-voltage phenomena and particle accelerators. The year was 1932—marked in nuclear science by the first completely artificial disintegration of the atomic nucleus and the discovery of the neutron. In that year Cockcroft and Walton at the famous Cavendish Laboratory in Cambridge, England, using machine-accelerated protons, had bombarded the lithium isotope $_3Li^7$, producing occasionally an unstable nucleus which disintegrated into two oppositely recoiling alpha particles with 17 million electron-volts of kinetic energy. In the same year, Chadwick in England identified as a new uncharged particle with the mass of a proton the mysteriously penetrating radiation first observed by Bothe and Becker in Germany. The neutron soon proved to be the key which unlocks the vast store of nuclear energy.

VAN DE GRAAFF ACCELERATOR

IN THESE INTERVENING YEARS, the Van de Graaff generator, applied to the acceleration of light positive ions, has proved to be the most suitable instrument for obtaining precise information about the intricate structure of the atomic nuclei. Academic and national laboratories for nuclear research around the world are equipped with such electrostatic accelerators today, most of them built by the High Voltage Engineering Corporation headed by my wartime friend, Dr. Denis Robinson. These accelerators produce accurately monoenergetic beams of protons, deuterons, and alpha particles with controllable energies up to 10 million electron-volts to elicit detailed nuclear energy-level data. More recently, the "tandem" principle of double and triple acceleration has greatly increased the particle energy that can be obtained. Moreover, heavier ions may now be used as atomic bullets in nuclear research, and far more intense particle beams are in the offing.

My research project, inspired by Van de Graaff, was an investigation of the possibilities of vacuum-insulated electrostatic machinery for power generation and conversion purposes. These machines were essentially multipolar metallic disks running at high speed in vacuum between stator disks. If electric gradients of a half million volts per centimeter could be insulated between stator and rotor, such varying-capacitance generators and motors could develop a power compactness comparable to that of our most advanced electromagnetic machinery. Many of us, including Prof. Dugald Caleb Jackson, head of MIT's Electrical Engineering Department who frequently dropped in to see how things were going, were impressed with the possibilities of this approach. These high gradients, however, are not yet possible in high vacuum over large electrode areas, especially at voltages over a few hundred thousand volts. My first small vacuum-insulated electrostatic machine developed about 60 watts of power with an efficiency of over 99%.

The recent advent of the Space Age has naturally revived interest in vacuum-insulated electrostatic generators. Outside the earth's atmospheric blanket there exists—"for free" and pervading all outer space—a finer vacuum than can readily be produced in the labora-

J. G. Trump is with the High Voltage Research Laboratory, Department of Electrical Engineering, Massachusetts Institute of Technology, Cambridge, Mass.

tory. Moreover, electrostatic machines have several characteristics uniquely advantageous in outer space where energy losses can be dissipated only by radiation: an extraordinarily high efficiency and the ability to operate at high temperature. To one who has long considered high vacuum as a basic insulating medium, uniquely necessary for the acceleration of charged particles, these space-exploration reasons for investigating with new vigor the factors which may enhance the voltage- and gradient-insulating properties of high vacuum are very encouraging indeed.

X-RAY SOURCES

THE APPLICATION of energetic atomic particles and radiation to medicine had its beginning within months of Roentgen's discovery of X rays in November 1895. By 1935, X rays produced at 200 kv were fairly common in many countries for the treatment of malignant disease. At this time, Coolidge's hot tungsten filament was the electron source in most X-ray tubes, and the Wimshurst disk generator and induction coil of the previous decades had been replaced by transformers, usually with vacuum-tube rectifiers. A few adventurous radiologists, seeking the more penetrating X rays produced at higher voltages, were using 400-kv sources and looking for higher voltages.

The million-volt air-insulated Van de Graaff belt generator applied to a 10-foot-long acceleration tube at the Huntington Memorial Hospital in Boston was impressive, both because of its awesome size and the more favorable properties of its radiation. The first patient was treated with it by Dr. Richard Dresser in March 1937. Along with General Electric's 1-million-volt resonance transformer installed at the Memorial Hospital in New York City and Metropolitan-Vickers' 1-million-volt transformer–rectifier at the St. Bartholomew Hospital in London, these were the first medical X-ray sources to reach the megavolt range.

Our second medical X-ray source, developed with my young associate Robert W. Cloud, insulated its 1.25 million volts with compressed-gas insulation. It was first used for therapy in the spring of 1940 and remained in clinical use at the Massachusetts General Hospital for over 15 years. Today over 40 two-million-volt Van de Graaff electrostatic X-ray sources are used in the treatment of an estimated thousand patients a day. In addition, a wide variety of megavolt X-radiation sources have become available, including betatrons, microwave linear accelerators, resonance transformers, and the gamma rays from the pile-produced isotope, cobalt 60.

Appreciation is now widespread and still growing that megavolt X rays offer advantages over conventional voltages for most patients. These benefits arise in part from the greater penetration of such X rays and from their diminished effect both on the radiation-sensitive skin and on the bony structures. Megavolt X radiation has thus made possible the delivery of more adequate doses to the tumor site with less reaction on surrounding normal tissue.

At MIT's High Voltage Research Laboratory, a physical and clinical program with 2-million-volt X rays has been in progress for the past 10 years with the medical co-operation of Dr. Magnus I. Smedal and his associates at the Lahey Clinic in Boston. About 40 patients are treated each day, often by use of novel physical methods of localizing the radiation dose. The technique of rotational therapy, in which the patient is rotated slowly in a stationary X-ray beam so that only the selected tissue region is continuously irradiated, the careful shaping of the X-ray beam cross section so as to include the involved regions but exclude normal tissue, the selective protection during rotational therapy of radiation-sensitive organs such as the spinal cord, the precise location of the treatment field, and other practical aspects of megavolt radiation therapy have been developed or advanced in this work.

X rays are the electromagnetic radiation produced by the sudden stopping of high-energy electrons on a target. The direct use of energetic electrons has also been of great interest to us. My colleague Kenneth A. Wright is applying streams of electrons, accelerated to a controllable energy of 1 to 4 million volts, to a wide variety of purposes. Most dramatic is the direct application of electrons to the control of superficial radiation-responsive disease in humans.

EFFECTS OF ELECTRONS

ELECTRONS, first identified by J. J. Thomson in 1897, as tiny, negatively charged particles, are the basic stuff of electrical engineering. They are the sole repository of negative electric charge, the lightest, the most numerous, the swiftest, the most readily available, and to my mind the most beneficent of the elementary particles of nature. Accelerated to high energy in vacuum, they can pass through a thin metal window into air as a directed beam of ionizing energy. Two-million-volt electrons have a maximum range of about 8 meters in air, or 1 centimeter in water. Within this range, which is controlled by the voltage, they are capable of exerting profound biological, chemical, and physical effects. Superficial lesions—even those which are very extensive in area—can be efficiently treated, because no energy is delivered beyond their controllable range. Several hundred patients have received electron therapy in the MIT–Lahey Clinic program, often with remarkable benefit.

At far higher dosages, electron irradiation can sterilize pharmaceuticals and surgical materials, inactivate viruses, increase the shelf life of foods, produce interstitial atoms in solid-state materials, improve the recovery time of silicon diodes, cross-link polyethylene, and polymerize hydrocarbon monomers. Fortunately for the future radiation needs of the processing and chemical industries, it is now possible to contemplate the production of hundreds of kilowatts of megavolt electron power from a single low-cost unit.

This quest for megavolt sources of higher power for particle accelerators touches on some important aspects of the central activity of electrical engineering—the

generation, transmission, and conversion of electric power. Here on the Cornell campus some imaginative research, including the development and testing of high-voltage cables, is stimulating both to the technology of the future electric power systems of our country and to the instruction of young electric power engineers. The membership of the AIEE has a deep interest in the problems of extra-high-voltage a-c power transmission, now being explored analytically and experimentally in anticipation that the present 175 million kw of generating capacity in the United States will increase, perhaps tenfold, by the end of the century.

At these future voltages and power levels, the opportunities and problems offered by d-c power transmission deserve thoughtful re-examination. In Europe, real progress has been made during the past 10 years in resolving the a-c/d-c conversions and other problems of such d-c systems. The d-c English Channel interconnection of the French and English power grids, and the proposed 300-mile 800-kv d-c Moscow–Donbas system illustrate the vitality of this work. I believe that the experience which has been gained with megavolt constant-potential sources for particle accelerators can contribute in an important way to the power system development of this country.

Low-Frequency Parametric Amplification By Means of an Induction Machine

R. A. ELCO

Although parametric amplifiers are commonly considered as components for use at microwave frequencies, there is no inherent frequency limitation. The gain and bandwidth relationships for a negative-resistance parametric amplifier can be used at a 60-cycle signal frequency.

THE BASIC PRINCIPLES of parametric amplification were proposed by Lord Rayleigh, in connection with nonlinear acoustic phenomena,[1] and by Hartley[2] in 1930 to describe the operation of certain types of modulators. In the past 10 years this type of amplifier has attracted much attention because of favorable low-noise properties and useful gain at microwave frequencies.[3] However, the mechanism which provides gain at microwave frequencies can also provide gain at low frequencies. For instance, a simple circuit incorporating the parametric mechanism comprises a lossless resonant circuit containing a capacitor with plates that can be moved together and apart periodically.[4] Assuming an initial charge Q on the capacitor, movement of the plates apart causes the capacitance to decrease. Therefore, from $Q = VC$, the voltage rises and the energy in the circuit $\frac{1}{2} QV$ increases as a result of the mechanical work on the plates. The resonant circuit allows this energy to be applied to a load under the control of a signal voltage. Thus, a parametric amplifier is basically a modulator employing a nonlinear or time-varying energy-storage element.[5-7] The time-varying energy-storage element can be either a capacitor or an inductor; however, at low frequencies, such as 60 cps, the time-varying inductor is the most practical element to use.

The time-varying inductance needed for such an amplifier can be obtained at power frequencies by using the windings of an induction machine in such a way that the terminal inductance is a function of time when the machine is driven at some angular speed. One particular arrangement which is treated is the single-phase short-circuited rotor connection.

NEGATIVE-RESISTANCE PARAMETRIC AMPLIFIER WITH TIME-VARYING INDUCTANCE

THE negative-resistance parametric amplifier equivalent circuit, with a time-varying inductance, is shown in Fig. 1. The signal and the time-varying inductance are sinusoidal functions of time, and the filter comprising the series combination of L and C is resonant at the signal frequency. Included in the total inductance L is the average value of the time-varying inductance. Any losses that are present in the filter and the time-varying inductance are represented by a resistance R_m, and the load is a resistance R_L. Since the source of energy is the time-varying inductance, it will be termed the "pump."

Because of the filter, the only current that can flow is a current at the signal frequency ω_s, or one at a frequency very close to the signal frequency. Hence, the current $i(t)$ can be expressed as:

Essentially full text of the paper awarded First National Student Prize for 1959-60. Recommended for publication by the AIEE Educational Publications Committee.

R. A. Elco is a graduate student, Electrical Engineering Department, Carnegie Institute of Technology, Pittsburgh, Pa.

$$i(t) = I_m \sin(\omega_s t + \alpha) \quad (1)$$

Two conditions are to be considered: (1) when the pump frequency is exactly twice the signal frequency; and (2) when the pump frequency is not twice the signal frequency.

Condition 1: $\omega_p = 2\omega_s$. From Kirchhoff's voltage law, the signal voltage v_s in Fig. 1 is

$$v_s = i\,(R_L + R_m) + L\frac{di}{dt} + \frac{1}{C}\int i\,dt + \frac{d}{dt}[L(t)\,i(t)] \quad (2)$$

Since the power relationships in the circuit are of primary interest, consider the average power of each of the terms in equation 2.

Because the filter losses have been included in R_m, the terms $iL\,di/dt$ and $1/C\int i\,dt$ are zero when averaged over the period of the signal or an integral multiple of this period. The resulting average power terms are:

$$\frac{1}{T}\int_0^T i\,v_s\,dt = \frac{R_L + R_m}{T}\int_0^T i^2\,dt + \frac{1}{T}\int_0^T i\frac{d}{dt}[i(t)\,L(t)\,dt \quad (3)$$

in which $T = 1/f_s$. If the power dissipated in the load R_L is to exceed the power supplied by the signal, the second term of the right side of equation 3 must be less than zero, or

$$\left\{\frac{1}{T}\int_0^T i\frac{d}{dt}[i(t)\,L(t)]\,dt\right\} < 0 \quad (4)$$

Under this condition, the pump does not absorb power at the signal frequency but rather supplies power.

The signal voltage and inductance variation in Fig. 1 are given by

$$v_s = V_m \sin\omega_s t\;;\quad L(t) = L_m \sin(\omega_p t + \phi) \quad (5)$$

Substituting (1) and (5) in equation (3) and integrating gives

$$\frac{I_m V_m}{2}\cos\alpha = \frac{I_m^2}{2}\left[R_L + R_m - \frac{\omega_s L_m}{2}\cos(\phi - 2\alpha)\right] \quad (6)$$

where the quantity $(\omega_s L_m/2)\cos(\phi - 2\alpha)$ has the units of ohms and is an apparent negative resistance R_n in the circuit.

The power gain of the circuit is

$$G_p = \frac{P_{out}}{P_{in}} = \frac{I_m^2 R_L}{I_m V_m \cos\alpha} \quad (7)$$

and substitution of equation 6 into equation 7 gives

$$G_p = \left[1 + \frac{R_m}{R_L} - \frac{\omega_s L_m}{2 R_L}\cos(\phi - 2\alpha)\right]^{-1} \quad (8)$$

Thus, the gain is dependent on the signal frequency ω_s, the amplitude of the time-varying inductance L_m, and the load R_L. To maximize the gain with a constant load R_L, the phase angle ϕ of the inductance variation with respect to the signal frequency should be zero since α is zero for $\omega_p = 2\omega_s$. If the term $(\omega_s L_m/2R_L)\cos(\phi - 2\alpha)$ is equal to $(1 + R_m/R_L)$ the gain is infinite and the circuit may oscillate if there is a suitable disturbance (such as noise) to start signal currents flowing.

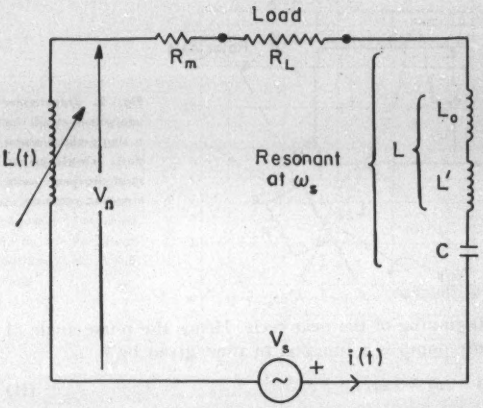


Fig. 1. Negative resistance parametric amplifier using a time-varying inductance.

Condition 2: $\omega_p \neq 2\,\omega_s$. In this case, the difference frequency $\omega_p - \omega_s$ is no longer equal to the signal frequency and if the difference frequency is much greater than or much less than the signal frequency, no current at the difference frequency can flow because of the filter. Therefore, the pump no longer represents a negative resistance and the gain is less than unity.

However, if the difference frequency is very close to the signal frequency, current at the difference frequency can flow because of the finite bandwidth of the filter. The impedance seen by the difference frequency voltage that appears across the pump is the impedance of the load and the filter. Because of the filter, the difference-frequency current I_d is reduced in amplitude and α_d, its phase angle with respect to the difference-frequency voltage across the pump, is increased. The approximate power flow out of the pump at the difference frequency is

$$P_p \cong I_d\,V_d\cos\alpha_d \quad (9)$$

which decreases as the absolute value of $\omega_d - \omega_s$ increases. Since the magnitude of the negative resistance is proportional to P_p, the negative resistance term in equation 8 is multiplied by the factor β,

$$\beta = \left\{1 + \left[\frac{(\omega_p - \omega_s)\,L - 1/(\omega_p - \omega_s)\,C}{R_L + R_m}\right]^2\right\}^{-1}\left[\frac{\omega_p - \omega_s}{\omega_s}\right]^2 \quad (10)$$

which is derived from equations 2, 6, and 9, where the current i is considered to have components at ω_s and $\omega_p - \omega_s$.

The average powers in equation 6 were obtained by integrating the instantaneous power over one cycle of the signal, treating the phase angle ϕ of the pump as a constant. However, when the pump frequency is not exactly equal to twice the signal frequency, ϕ changes from the beginning of one cycle of the signal to the

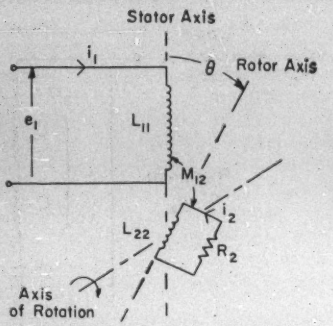


Fig. 2. Transformer equivalent circuit for a single-phase stator and single-phase short-circuited rotor induction machine.

beginning of the next cycle. Hence the phase angle of the pump is a function of time, given by

$$\phi = (\omega_p - 2\,\omega_s)\,t \tag{11}$$

Substitution of equations 10 and 11 into equation 8 gives the general expression for the gain of a negative resistance parametric amplifier with a time-varying inductance as the pump:

$$G_p = \left\{1 + \frac{R_m}{R_L} - \frac{\omega_s L_m}{2 R_L}\,\beta \cos\left[(\omega_p - 2\omega_s)\,t - 2\alpha\right]\right\}^{-1} \tag{12}$$

The feasibility of constructing a negative-resistance parametric amplifier to operate at signal frequencies of 60 cps is largely determined by realizable values of the ratio of $\omega_s L_m$ to R_L which control the gain in equation 8. If $\phi = 2\alpha$, the gain becomes infinite when

$$\frac{\omega_s L_m}{2 R_L} = 1 + \frac{R_m}{R_L} \tag{13}$$

Equation 13 indicates that with a time-varying inductance of amplitude 5×10^{-2} henrys and negligible losses ($R_m \approx 0$) used in the circuit of Fig. 1, reasonable gains should be obtained with a load resistance R_L of 10 ohms, at a signal frequency of 60 cps.

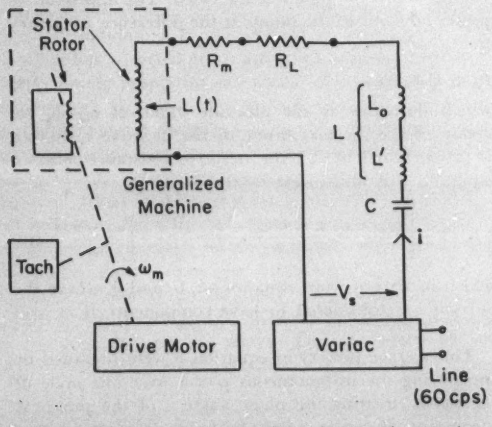


Fig. 3. Experimental circuit-connections for machine A with single-phase stator and rotor, where $L_o = 0.22$ henry, $L_m = 0.2$ henry, $L' = 0.04$ henry, $C = 28$ μf, $R_m = 3.0$ ohms, and $R_s = 34$ ohms.

A-C INDUCTION MACHINE AS TIME-VARYING INDUCTANCE

An induction machine may be described as a transformer in which the primary winding (stator) is stationary and the secondary winding or windings (rotor) rotate about an axis perpendicular to the axis of both windings.[8] From Fig. 2 there is a mutual inductance $M_{12} = M_{12} \cos\theta$ between the stator and rotor windings, which is a function of the angular position of the rotor. If the rotor is short-circuited and rotated slowly, the inductance seen at the stator terminals as a function of θ can be found from the solution of equations

$$e_1 = L_{11}\frac{di_1}{dt} + \frac{d}{dt}(M_{12}\,i_2);\; 0 = i_2 R_2 + L_{22}\frac{di_2}{dt} + \frac{d}{dt}(M_{12}\,i_1) \tag{14}$$

where L_{11} is the self-inductance of the stator and L_{22} is the self-inductance of the rotor. Solution of equation 14 for the ratio of e_1/i_1, when $R_2 \approx 0$ gives for the effective inductance of the stator

$$L(\theta) = \frac{\hat{M}_{12}^2}{2\,L_{22}}(1 + \cos 2\theta) \tag{15}$$

For confirmation of this expression, measurements were made of stator inductance for various angular positions of the rotor (at rest) with a single-phase short-circuited rotor in the MIT–Westinghouse generalized machine[9] recently available in the laboratory. The measured parameters of the machine with this connection agreed with results predicted by equation 15.

The amplitude of the static inductance variation obtained is the right order of magnitude for practical use in a parametric amplifier. However, new difficulties arise because of additional induced voltages and currents in the rotor when the rotor is driven at some angular speed ω_m. These rotational currents will affect, to some degree, the magnitude of the inductance variation seen at the stator terminals. For an angular speed of ω_m the mutual inductance becomes $M_{12} \cos \omega_m t$ and if the reactance $\omega_2 L_{22}$ is assumed to be small compared to the rotor resistance, from equation 14 the voltage across the stator is

$$e_1 = -\frac{1}{R_2}\left\{i_1\left[\frac{d^2M_{12}}{dt^2}\,M_{12} + \left(\frac{dM_{12}}{dt}\right)^2\right] + \frac{di_1}{dt}\left[3\,M_{12}\frac{dM_{12}}{dt} - R_2 L_{11}\right] + \frac{d^2 i_1}{dt^2}[M_{12}]^2\right\} \tag{16}$$

The explicit form of the time variation of the inductance is not clearly evident from equation 16, which indicates that the machine cannot be replaced exactly by an equivalent time-varying inductance since it is not of the general form $e_1 = L\,(di_1/dt) + i_1\,(dl/dt)$ which gives the voltage across a time-varying inductance. However, physical reasoning and the experimental results of the next section suggest that at any speed other than ω_m equal to ω_s, where ω_s is the synchronous speed, the machine can be approximated by a time-varying inductance.

At synchronous speed, the machine is similar to a synchronous machine operating with a short-circuited field winding and with no direct-current excitation of the field. Hence, there can be no transfer of mechanical or electric power in the machine. Since a time-varying inductance implies a transfer of energy stored in the field to an external circuit, the machine when driven at synchronous speed is not a time-varying inductance and appears only as a positive resistance. Further justification of this reasoning follows from the torque–speed characteristic of a single-phase induction machine, which shows that at speeds less than or greater than synchronous speed, power transfer does take place. The phenomenon of self-excitation of induction machines (induction generators)[10] also implies such power-transfer considerations.

From this reasoning and from a comparison of the difference-frequency voltage V_d for a time-varying inductance to that for an induction machine, the $L(t)$ seen at the stator terminals of a 2-pole single-phase induction machine with a single-phase short-circuited rotor will be taken as

$$L(t) \cong \left| \frac{(\omega_p - 2\,\omega_s)}{2\,R_2}\, \hat{M}_{12}^2 \right| \sin\,(\omega_p t + \phi) \qquad (17)$$

where $\omega_p = 2\,\omega_m$. The amplitude of equation 17 was determined for the condition $L_{22} \approx 0$, and for any practical machine this condition is not very realistic. However, equation 17 is useful qualitatively because it shows that the variation of the amplitude of $L(t)$ with ω_p is linear and for ω_p close to 2 ω_s it can be used as an approximation to $L(t)$.

EXPERIMENTAL INVESTIGATION OF PARAMETRIC MACHINE AMPLIFIERS

TWO DIFFERENT MACHINES were used as the time-varying inductance in the experimental investigation. The first[9] was the MIT–Westinghouse "generalized machine" (machine *A*) with the single-phase rotor connection, and the second was a commercial 3-phase wound-rotor induction motor (machine *B*). The circuit connections and parameter values for machine *A* are given in Fig. 3, in which the average value of the measured $L(t)$ is included with the inductance of the filter (L and C).

From the theoretical expression (equation 12), the critical load R_C for the power gain to become infinite was calculated for each machine. Then in order to check these predictions and other theoretical conclusions, the test cycle which follows was conducted. Initially the input signal power was held constant, with a particular R_L, and the power gain determined as a function of the (angular) mechanical speed ω_m of the driven induction machine. Then the mechanical speed was held constant at the value which gave maximum gain with the particular R_L, and the gain was determined as a function of signal input power. Finally, R_L was reduced below R_C so that the circuit became oscillatory and, in this condition, the output power was observed as a function of the angular speed of the induction machine. The signal frequency for these tests was 60 cps.

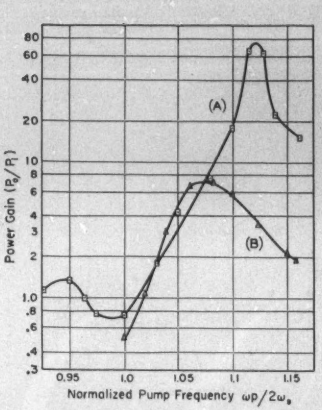


Fig. 4. Power gain of experimental machine parametric amplifiers as a function of normalized pump frequency. Machine *A*, $R_L = 28$ ohms; machine *B*, $R_L = 4.5$ ohms.

At a pump frequency ($\omega_p = 2\,\omega_m$) of 120 cps, the gain for both machines was a minimum (Fig. 4), as expected, since L_m is zero at $\omega_p = 2\,\omega_s$. The mechanical power supplied to the shaft of $L(t)$ by the drive motor was also a minimum at this speed, indicating that the dip in gain was not a consequence of extra losses arising at this frequency. The pump frequency at which maximum gain was obtained was 135 cps for machine *A* and 130 cps for machine *B* in the single-phase short-circuited rotor connection. For given values of R_L, the maximum gain obtained corresponded to the theoretical values expected from equation 12. The theoretical and experimental gains of the machine *B* amplifier as a function of the load resistance R_L are given in Fig. 5.

For values of R_L less than R_C, the circuit always behaved as an oscillator. This mode of operation was initiated by adjusting the pump to the frequency at which maximum gain was obtained and then applying a signal voltage of 1 or 2 volts. The load current then increased as oscillation began. Once this occurred, the signal voltage could be reduced to zero and the signal source short-circuited without affecting the current in the load. The output power as a function of pump frequency when the circuit is an oscillator is given in Fig. 6.

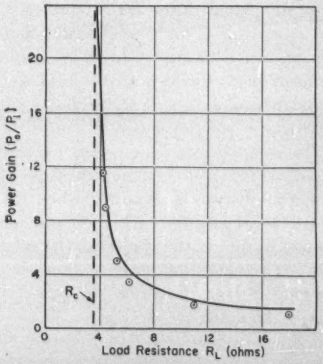


Fig. 5. Theoretical and experimental power gain for machine *B* with pump frequency = 130 cps.

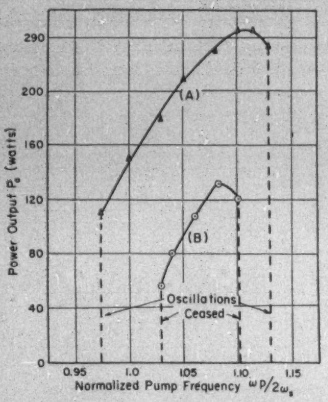


Fig. 6. Output power of experimental machine parametric oscillators. Machine A, $R_L = 21$ ohms; machine B, $R_L = 3.6$ ohms.

The experimental pump frequency at which maximum gain is obtained is displaced from $\omega_p/2\omega_s = 1$ because of a change in the amplitude (L_m) of $L(t)$ in the region where $\omega_p/2\omega_s = 1$. The experimental values of L_m as a function of pump frequency, as obtained by solving equation 12 for L_m and substituting the experimental values for G_p, R_m, and R_L, indicate that the variation of L_m with ω_p is approximately linear, as was expected from equation 17. Since R_n is proportional to L_m, the gain curve is modified, as seen in Fig. 4, where the notch is caused by the decrease in L_m at $\omega_p/2\omega_s = 1$. The difference in the height of the peaks for machine *A* in Fig. 4 is due to asymmetry of the gain relationship (equation 12) and might also be caused, in part, by a change in the average value of $L(t)$, which would change the resonant frequency of the filter.

CONCLUSIONS

1. The experimental results obtained with an induction machine as the time-varying inductance indicate that the theoretical discussion in this article, in general, describes the physical circuit and that predicted gains can be obtained at signal frequencies of 60 cps. The derivation of and reasoning on the equivalent circuit for the induction machine hinge on the assumption that the machine can be treated as a linear system. This description is sufficient when relatively small powers are dissipated in the load. However, when the machine is operating at high power levels it is obvious that the nonlinearity resulting from saturation of the iron will cause the behavior of the amplifier to deviate from that which is predicted by the linear analysis. This is evident when the machine is operated as an oscillator. The angular speed at which maximum power output is obtained is shifted slightly from the speed at which maximum gain is obtained when the machine is operated as an amplifier (Figs. 4 and 6). The small differences in speeds and the similarity of the curves obtained in each condition indicate that the linear analysis is accurate over the range of power levels investigated experimentally.

The amplitude L_m of the time-varying inductance that the machine presents at its terminals is important only over the range of angular speeds for which gain would be obtained if L_m were constant, since beyond this range the resonant circuit prevents the necessary currents from flowing and the gain is less than unity regardless of the value of L_m. Hence, the description of L_m as a function of the pump and signal frequencies as presented is sufficient.

2. This general demonstration of 60-cps parametric amplification presents a new and unusual application of an induction machine. The ease with which this type of amplifier can be constructed at 60 cps makes its use as an educational aid extremely attractive. Focus can be placed upon the basic principles of parametric amplification without involvement in the special techniques of making measurements at very high frequencies.

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Sound Waves Salvage Equipment

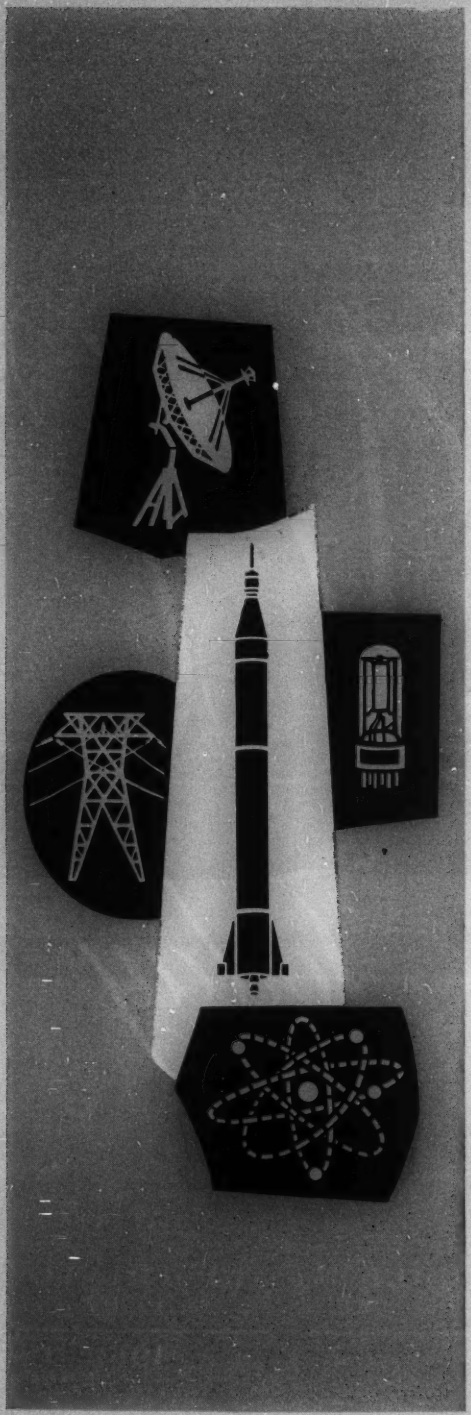
Sound waves are currently being used by electronic mechanics at the New York Naval Shipyard for salvaging equipment that was damaged by smoke and salt water in last December's fire on the aircraft carrier *U.S.S. Constellation*. The ultrasonic power unit, recently installed by the Westinghouse Electric Corporation, sends ultrahigh-frequency sound into a tank containing a special cleaning solution. Dirt is cleaned away by the action of tiny bubbles which are formed and then exploded by the sonic pressure waves. The cleaning technique is being used on the carrier's motors, controls, and transformers, as well as the electronic equipment. Fire damage to the *Constellation*, originally put at $78 million, is now estimated at $48 million. It is anticipated that the rehabilitation of the ship will be completed by December 1961.

AIEE Today

HIGHLIGHTS OF THE YEAR

American Institute of Electrical Engineers

1960–1961



AIEE presents this report on its 77th year in a new condensed format so that more information can be brought to all its members. Full details about all activities are available to the officers, committees, and any interested members.

The year just closed has been noteworthy for steady expansion of the Institute's major services in the stimulation, presentation, and dissemination of technical information through its meetings and publications. Of even greater significance have been the steps taken to meet the responsibilities and challenges presented by the rapidly changing environment of the profession.

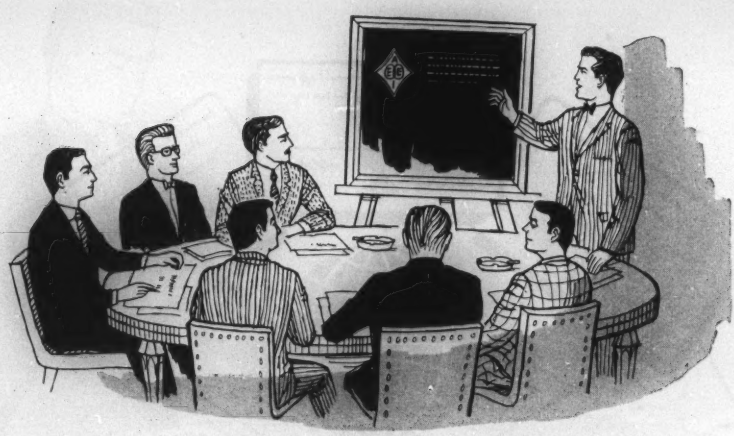
Recognizing that a broad attack is required for the solution of today's problems, and a variety of skills and experience must be coordinated and brought to bear on them, AIEE in 1960-1961 actively established new intersociety and interdisciplinary relations and cooperative activities.

AIEE has successfully borne the largest single share of the drive to raise funds for the most important cooperative project ever undertaken by the organized profession. The magnificent new United Engineering Center is almost ready for occupancy.

To better utilize the different backgrounds and experience of its membership on the management of its affairs, the Board of Directors has been expanded and the Executive Committee has assumed heavier administrative burdens. In addition, a program for the development and identification of future leadership has been inaugurated.

In presenting the following highlights of the year, the Board of Directors expresses its appreciation of the work of the thousands of members in the Sections, Branches, Committees, Divisions, Departments and other units of the Institute whose consistent and dedicated work resulted in another year of growth and progress in the service of the profession.

Meetings



MEETINGS, CONFERENCE ATTENDANCE AT ALL-TIME HIGH

AIEE continued its vital contribution to the advancement of the profession, disseminating and exchanging information through its meeting program. All major areas of interest to electrical engineers were touched on at a total of 42 meetings all over the country, on a national and district level.

The four General Meetings (Atlantic City, San Diego, Chicago, and New York), and three District Meetings (North Eastern at Providence, R. I., South East and South Central at New Orleans, and Great Lakes at Minneapolis), were attended by more than 9000 registrants.

The number of papers delivered at General Meetings in 1960-61 reached an all-time high of 1093. Largest was the Winter General Meeting in New York, where attendance was 4535. Four hundred and ninety-seven papers were delivered at this meeting.

The Pacific General Meeting was combined with the Aero-Space Transportation Conference.

ATTENDANCE AT STC's UP 10%

More Special Technical Conferences were held than last year, with an accompanying increase of sixteen percent in the number of papers. Twenty-eight of the thirty-six conferences showed a ten percent increase in attendance.

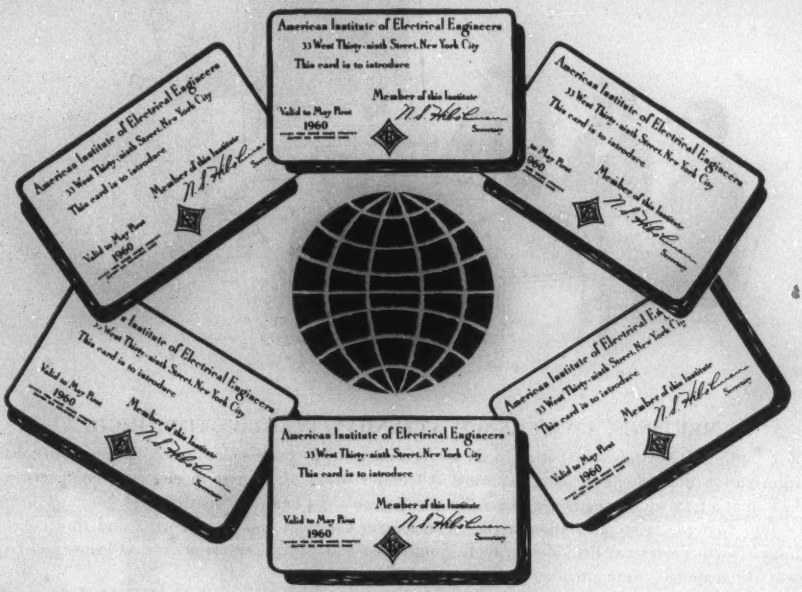
The STC's ranged in subject matter from computers to electric welding. Twenty-two of these gatherings were in cooperation with other organizations.

More than 1348 papers were heard by a total of 36,623 STC attendees. The National Electronics Conference, in Chicago, co-sponsored by AIEE, Illinois Institute of Technology and others, had a registration exceeding 12,000. One hundred papers were delivered. The American Power Conference in Chicago had 3000 attending. The Western Joint Computer Conference in San Francisco had more than 2000.

A list of STC subjects follows:

Electrical Applications in the Textile Industry
Education Frontiers in Biomedical Engineering
Western Joint Computer
Rural Electrification
Electronic Components
Appliance
Cement Industry
National Telemetering
Standards and Electronic Measurements
Aero-Space Transportation
Joint Automatic Control
Engineering Management
Industrial Electronics
National Power
Petroleum Industry
Non-linear Magnetics & Magnetic Amplifiers
National Electronics
Electrical Techniques in Medicine and Biology
Western Appliance
Power Industry Computer Application
Middle Atlantic Textile
Magnetism and Magnetic Materials
National Conference on Application of Electrical Insulation
Eastern Joint Computer
Reliability and Quality Control
International Solid State Circuits
Engineering Aspects of Magnetohydrodynamics
American Power
Thermoelectric Energy Conversion
Rubber and Plastics
Electric Heating
Materials Handling
Extra-high Voltage Cable
Electric Welding
Biomedical Engineering

Membership



MEMBERSHIP INCREASES TO 56,473

Membership numbered 56,473 for the period ending May 1, 1961. This is a slight increase over the number of members last year at this period. New applications numbered 4311. Student membership was 10,685.

Two new student branches were established, and six joint branches with IRE.

Changes were made in the constitution regarding students and their activities. They are now designated as Student Members instead of Student Associates and Student Affiliates.

NEW SECTIONS, SUB-SECTIONS FORMED

Section organizations continued to grow. Four new Sections were formed during the year, bringing the total to 119. They are Central Florida, Hudson Valley, North Alabama, and Hampton Roads Sections.

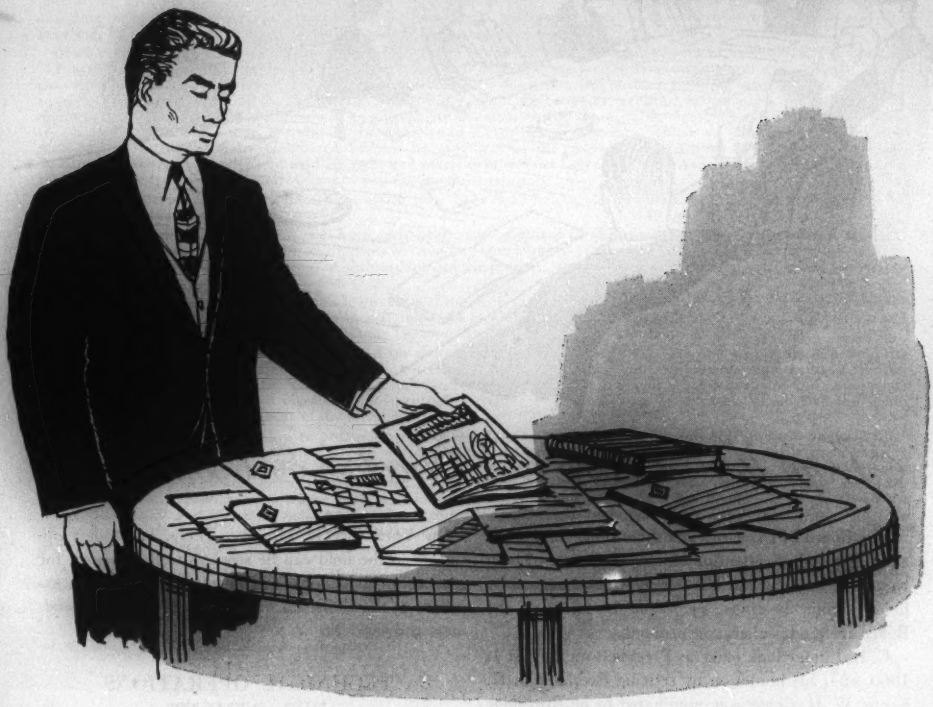
Three new sub-sections were formed: Gainesville, by the Jacksonville Section; Calumet and Fox Valley by the Chicago Section.

Much attention is being paid to getting new members in the Sections. A District competition has been organized, with a certificate award to the Section in each District which attains the highest number of new applications in proportion to Section membership.

The Annual Section Growth Award is based on a combination of increased membership and attendance. This year, the certificate and gavel went to the Seattle, and to the North Carolina Sections.

Some Section study group programs have been attended by as high as 75 percent of non-AIEE members.

Publications



ELECTRICAL ENGINEERING PRINTS THREE SPECIAL ISSUES

Electrical Engineering, in its choice of subject matter, was guided by the interests of the membership as evidenced in a 1960 survey. An entire issue was devoted to aero-space problems, and there were special issues in May and June on thermoelectric generation.

Electrical Engineering published 87 technical articles, 59 digests, and 21 general articles.

Continuing a yearly trend, costs increased about 5 percent. While advertising income declined $88,000, this appears to reflect the fact that the electrical industry was particularly hard hit by the business recession.

The three bi-monthlies: Communication and Electronics, Applications and Industry, and Power Industry and Systems, published a total of 2740 pages.

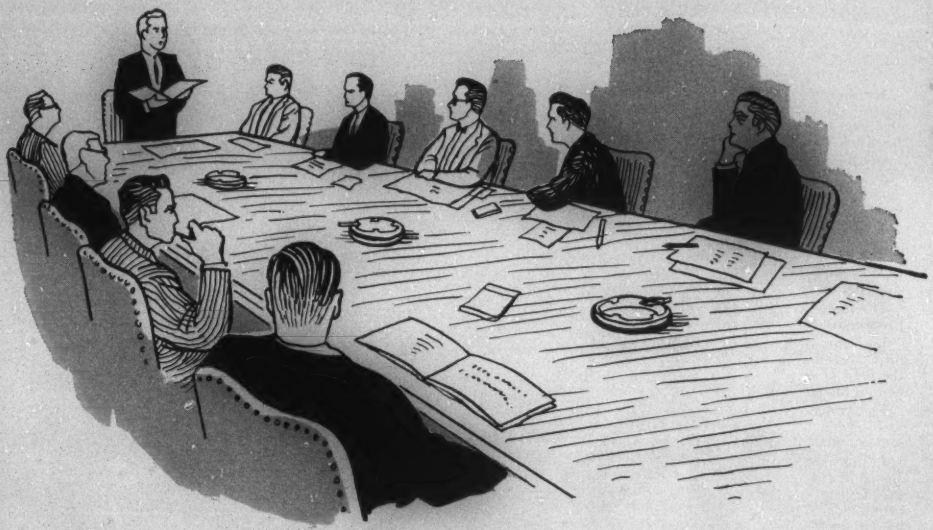
TEN-YEAR TRANSACTIONS INDEX PUBLISHED

Volume 79 of the AIEE Transactions was issued. Also published was a ten-year cumulative index of all Transactions papers published during 1950-59.

Six special publications and eight technical conference publications were issued.

Through its special publications committee, AIEE was requested by the government to translate and publish certain Russian technical journals in the electrical field.

Coverage of papers in Electrical Engineering was extended with the decision to provide 75 word abstracts of all papers instead of one page abstracts of selected papers.



From the Board of Directors & Committees

The Board of Directors met three times during the year, devoting its attention chiefly to matters of long range Institute policy. The Executive Committee, by holding four meetings, succeeded in releasing the Board from administrative problems.

C. H. Linder took office as President on August 1, 1960, after his induction by retiring President J. H. Foote. W. H. Chase was nominated to be President beginning August 1, 1961.

President Linder led the Board in a comprehensive study in depth of the fundamental purposes, historical development and the present environment of the Institute and its sister societies. This has been digested in two booklets: AIEE in 1960-61, and Climate for AIEE.

The United Engineering Center, a major project of the Founder Societies for several years, is now nearing completion. AIEE has been actively involved in promoting the building of this Center for American engineering activity, a symbol of professional unity. Scheduled for occupancy in the fall of 1961, it will finally house the electrical, and other engineering groups, under one roof. AIEE's goal was to raise $900,000 on the $12½ million building. On May 12, 1961, $880,957 of this sum had been pledged. AIEE will occupy three floors of the 20-story structure on United Nations Plaza in New York City.

The electrical engineering field will see a new landmark when AIEE launches the first national Electrical Engineering Exposition in 1962. The Exposition, a biennial event, will take place in conjunction with the annual Winter General Meeting in New York City in January. There, latest developments in the field can be seen, as well as heard, for the technical sessions will be supplemented with exhibits at the Coliseum of the newest electrical products and services.

TECHNICAL OPERATIONS DEPARTMENT

Closer working relationships between TOD and its counterparts in EJC Societies are the goal of an Ad-hoc committee of TOD.

TOD is now responsible for approving and scheduling locations and dates of authorized General Meetings, District Meetings and Special Technical Conferences.

Direct representation from the Department and the Divisions on the Board of Directors was instituted.

SPACE COMMUNICATION COMMITTEE, newly set up, sponsored its first technical session at the Winter General Meeting in New York.

RESEARCH COMMITTEE has sponsored several symposiums and meetings. It is particularly concerned with promotion of university research and intersociety cooperation.

SAFETY COMMITTEE is working on current proposals to revise the National Electrical Code with respect to required grounding of portable electric appliances.

From the President

My short term of office as President of the Institute has impressed me with the need for action and change on the part of the Institute if it is to maintain its position as a leadership society in the electrical field. In today's rapidly changing technological climate, there is a constant necessity to review—and revise—the activities and objectives of the Institute. To remain static or move forward slowly is not enough.

Of all the possible approaches, the most promising is the key idea of creative management of technology. The booklet "Climate for AIEE" sets forth this idea of management and describes the factors surrounding and governing it. These data have been widely distributed and have served to stimulate discussion and positive thinking—and in some instances to initiate action—capitalizing on the areas of opportunity in the exchange of technical information, the education of engineers, and professional development. The officers and the membership are working together realistically to approach the three objectives: true gain in value of the Institute to a growing membership; enhanced effectiveness in the conduct of the Institute's affairs; increased interest by members in intersociety relationships. My conversations with Institute members have convinced me that more and more members are becoming interested and are anxious to become involved in the forward-looking programs now operating or in prospect.

The many Special Technical Conferences which have been held in cooperation with other groups are examples of progressive unity-in-fact.

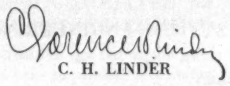
Both the Presidents of AIEE and IRE have exchanged visits at Board of Directors' meetings where mutual opportunities were freely discussed, and the similarities in concepts of management of technology were noted. For example, in the field of education, the cooperation at the student branch level is considered to be most important, and the extension of membership in ECPD is indicative of this.

The Functional Plan continued to gain momentum through the meetings of the Presidents of the interested societies and the renewed vigor with which EJC is identifying areas of obligations of the Engineering Profession to Society, and seeking methods by which EJC can contribute to the overall coordination of technical information flow.

In the light of AIEE's acceptance of the need for change and its corollary need for planning a program of action, the Board of Directors has authorized a Special Committee to study independently, and without restrictions, the activities, policies and philosophies of the Institute. The members of this Committee will delineate a realistic and courageous program for future action on all phases of the Institute's activities, but with particular emphasis on charter and scope truly reflecting the wants and needs of the membership.

As we watch the work develop, I recommend we keep in mind the message in the quotation from C. P. Snow: *"More often than I like, I am saddened by a historical myth. Whether the myth is good history or not, doesn't matter; it is pressing enough for me. I can't help thinking of the Venetian Republic in their last half-century. Like us, they had once been fabulously lucky. They had become rich, as we did, by accident. They had acquired immense political skill, just as we have. A good many of them were tough-minded, realistic, patriotic men. They knew, just as clearly as we know, that the current of history had begun to flow against them. Many of them gave their minds to working out ways to keep going. It would have meant breaking the pattern into which they had crystallized. They were fond of the pattern, just as we are fond of ours. They never found the will to break it."**

Altogether these programs which are in progress make me confident that the Institute will meet the challenges of an ever-growing, dynamic technology. It has been a privilege to serve the Institute and its membership as President in this past year.



C. H. LINDER

*C. P. Snow, "*The Two Cultures and the Scientific Revolution*."

SEMI-CONDUCTOR RECTIFIER COMMITTEE will co-sponsor the quintennial industry-wide meeting in 1962 on Rectifiers in Industry.

INSULATED CONDUCTORS COMMITTEE presented a report on their Soil Resistivity research project, Soil Thermal Characteristics in Relation to Underground Cables. The 5-year project was financed by several interested organizations. EHV Cable Conference was held in Elmira and Ithaca.

POWER GENERATION COMMITTEE arranged field trip meetings to inspect the latest computer controlled plants.

COMMUNICATION DIVISION COMMITTEE sponsored the Fifth National Symposium on Global Communications. Application has been made for funds to translate three Russian journals.

CHEMICAL INDUSTRY COMMITTEE is helping set up specifications covering definitions of terms and test procedures of industrial type batteries.

FUNDAMENTAL ELECTRICAL STANDARDS COMMITTEE is working on a specification for Standard Capacitors.

TELEMETERING COMMITTEE has submitted a list of definitions of telemetering terms to the Standards Committee.

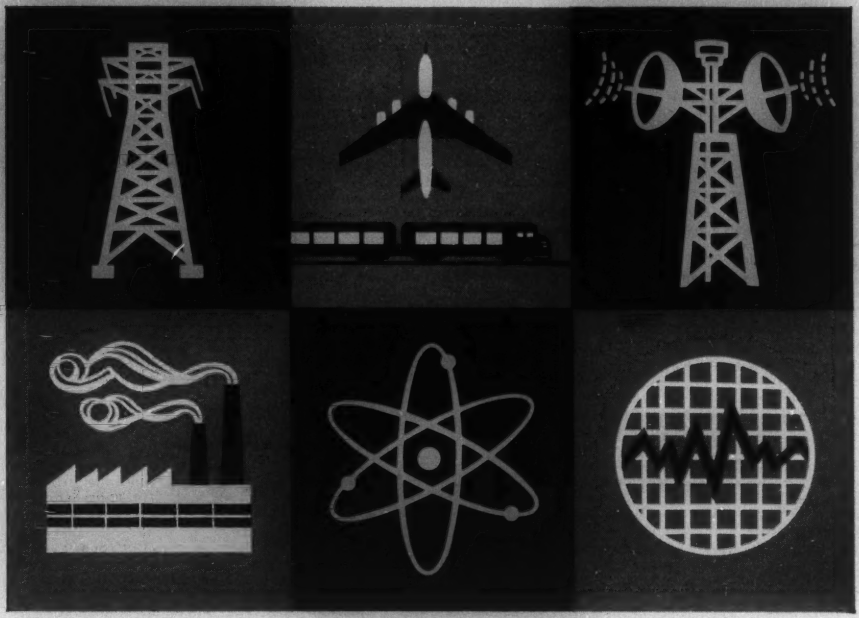
INDICATING AND INTEGRATING INSTRUMENTS COMMITTEE has up-dated and revised the report, Progress in the Art of Metering.

TEXTILE INDUSTRY COMMITTEE is studying operation temperatures of electrical equipment enclosures in textile plants.

INDUSTRIAL AND COMMERCIAL POWER SYSTEMS COMMITTEE is revising, in cooperation with ASA, the Red, Green, and Gray Books.

ELECTRIC HEATING COMMITTEE is pre-

(Continued on next page)



paring data on electric heating processes, along with thermal and electrical properties of materials.

SYSTEM ENGINEERING COMMITTEE is working on a list of definitions for control terminology.

ROTATING MACHINERY COMMITTEE has revised and recommended as full status AIEE Standards: AIEE No. 58, Standard for Induction Motor Letter Symbols; and AIEE No. 67, Guide for Operation and Maintenance of Turbine Generators.

MAGNETIC AMPLIFIERS COMMITTEE—Special Technical Conference on Non-linear Magnetics heard 27 papers. Fifteen of these were awarded Transaction status.

SOLID STATE DEVICES COMMITTEE is gathering material for a special summer issue of Electrical Engineering on microsystems electronics.

STANDARDS COMMITTEE approved nine standards. A Joint Standards Committee was set up with IRE.

SWITCHGEAR COMMITTEE has work underway on standards for new temperature rise limitations, rated capacitor current switching, and capacitor switching.

TRANSMISSION AND DISTRIBUTION COMMITTEE published a Bibliography on Power Capacitors covering the period 1956-59.

COMPUTING DEVICES COMMITTEE issued its first newsletter. It took part in several joint Computer Conferences.

ELECTRICAL INSULATION COMMITTEE prepared a handbook on the effects of radiation on insulating materials; took part in the Electrical Insulation Conference, co-sponsored by AIEE and NEMA.

ELECTRICAL TECHNIQUES IN MEDICINE AND BIOLOGY COMMITTEE co-sponsored a conference on Medicine and Biology.

Under the FEEDBACK CONTROL SYSTEM COMMITTEE sponsorship, AIEE will be host Society for the 1962 Joint Automatic Control Conference.

MINING INDUSTRY COMMITTEE is preparing a set of recommended practices for the industry.

INDUSTRIAL POWER RECTIFIERS COMMITTEE continues its work on standards.

MARINE TRANSPORTATION COMMITTEE took part in a technical conference of the International Electrotechnical Commission in Stockholm, Sweden.

LAND TRANSPORTATION COMMITTEE is working on Standards for semi-conductor power rectifiers.

AERO-SPACE TRANSPORTATION COMMITTEE reviewed several British aircraft standards and codes; also initiated a program aimed at producing a series of standards in the missile and space vehicle support field.

ELECTRONICS COMMITTEE has worked out an arrangement with the Solid State Devices Committee whereby a common membership serves both the New Energy Sources and Thermoelectric Devices Subcommittees. The purpose is interchange of information and coordination of activities. Each electronics subcommittee chairman has an adviser to work with him on developing new standards.

TRANSFORMERS COMMITTEE sponsored a total of six sessions at the General Meetings.

DATA COMMUNICATION COMMITTEE in its joint session at the National Electronics Conference and the COMMUNICATION THEORY COMMITTEE, at the Fall General Meeting, experimented with the reporter method of presentation and panel discussion.

PROTECTIVE DEVICES COMMITTEE is working on the revision of Standard No. 32 on Neutral Grounding Devices. New information on thermal aging of insulation will permit changes in thermal rates and temperature of grounding devices.

PROFESSIONAL DEVELOPMENT & RECOGNITION DEPARTMENT

Seven medals were awarded, including two new ones, and two fellowships.

The Edison Medal went to Harold S. Osborne; the Lamme Medal to Dr. John George Trump; the Medal in Electrical Engineering Education to Dr. Ernst Weber; the William M. Habirshaw Medal to S. B. Crary. Perry Borden received the Morris E. Leeds Award; Dr. Rudolph Kompfner the David Sarnoff Award and Dr. Mervin J. Kelly was first recipient of the Kelly Award. The Volta Fellowship went to Arrigo L. Frisiani, Genoa, Italy, a graduate student and instructor at the University of Michigan. The Fortescue Fellowship went to George W. Gruver, a graduate student at the University of Oklahoma.

The PRIZE AWARDS COMMITTEE recommended that medal awards be established in Power Generation, Basic Sciences and Materials, Utilization of Electrical Energy, and Service to the Institute and Literature.

The EDUCATION COMMITTEE presented a series of four meetings on Graduate Education, in cooperation with IRE and ASEE.

GENERAL ADMINISTRATION DEPARTMENT

Constitution and By-law amendments, sponsored by the General Administration Department, have opened student membership to those enrolled in science curricula offering suitable preparation for graduate study and practice in engineering.

The STUDENT BRANCH COMMITTEE, the EDUCATIONAL PUBLICATIONS COMMITTEE and the PUBLIC RELATIONS COMMITTEE cooperated again this year to publish five issues of EE Digest, student newspaper launched in 1959.

The Public Relations Committee was responsible for preparation and publication of 15 brochures, newsletters, and other literature.

AIEE-IRE Coordination Committee on Student Activities has been set up to study ways to get closer coordination between AIEE and IRE Student Branch activities.

An extensive program of Section Meetings brought the subject, "Organize the Engineering Profession for Unity" to the attention of the membership. Through active participation in ECPD and EJC, and cooperation with NSPE, AIEE continues to keep its members represented and informed on matters of broad engineering interest and concern. EJC has undertaken significant projects looking toward the identification and improvement of the channels for communication of technical information.

TRANSFERS COMMITTEE is revising a manual on transfers. Purpose is to encourage general information on grade, requirements, organization, and initiation of transfer applications.

HASKINS & SELLS
CERTIFIED PUBLIC ACCOUNTANTS

TWO BROADWAY
NEW YORK 4

Accountants' Report

American Institute of Electrical Engineers:

We have examined the balance sheet of American Institute of Electrical Engineers as of April 30, 1961 and the related statements of income and operating fund reserve and of restricted fund reserves for the year then ended. Our examination was made in accordance with generally accepted auditing standards, and accordingly included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

In our opinion, the accompanying balance sheet and statements of income and operating fund reserve and of restricted fund reserves present fairly the financial position of the Institute at April 30, 1961 and the results of its operations for the year then ended, in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

(*signed*) ***Haskins & Sells***

June 15, 1961

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Exhibit A — **Balance Sheet, April 30, 1961 and 1960**

ASSETS

	April 30, 1961	April 30, 1960
Property Fund Assets:		
Founder Society advances to United Engineering Trustees, Inc. (not repayable except upon latter's dissolution; 4% interest payable from date of occupancy of United Engineering Center)	$ 265,000	$ 265,000
Other properties at nominal values (library, works of art, etc.)	16	16
TOTAL PROPERTY FUND ASSETS	265,016	265,016
Restricted Fund Assets:		
Securities (market value 1961—$1,953,598; 1960—$1,694,252)	1,350,832	1,267,495
Cash	13,438	20,719
Accrued interest purchased	—	440
TOTAL RESTRICTED FUND ASSETS	1,364,270	1,288,654
Operating Fund Assets:		
Cash	106,031	53,075
Accounts receivable:		
Members—for dues	45,615	41,758
Advertisers (less reserve)	8,739	26,718
Advances for technical conferences and meetings	17,566	12,050
Subscriptions, etc.	29,651	46,722
Inventories—at cost or less:		
Transactions	25,122	23,135
Text and cover paper	30,738	41,908
Badges	3,777	5,256
Production charges for May and subsequent issues of *Electrical Engineering*	7,286	10,486
Prepaid expenses	14,277	13,428
Office equipment, furniture, and fixtures (less reserve for depreciation, 1961—$88,658; 1960—$77,082)	42,569	50,729
Expenditures applicable to United Engineering Center premises	4,651	
TOTAL OPERATING FUND ASSETS	336,022	325,265
TOTAL	$1,965,308	$1,878,935

LIABILITIES

	April 30, 1961	April 30, 1960
Property Fund Reserve:		
Founder Society advances to United Engineering Trustees, Inc.	$ 265,000	$ 265,000
Other	16	16
TOTAL PROPERTY FUND RESERVE	265,016	265,016
Restricted Fund Reserves (Exhibit C):		
Reserve Capital fund	1,271,380	1,199,518
Member-for-life fund	39,893	35,301
International Electrical Congress of St. Louis Library fund	6,616	6,616
Edison Medal fund	11,764	11,552
Edison Endowment fund	7,986	7,986
Lamme Medal fund	9,572	9,539
Mailloux fund	1,054	1,054
Volta Memorial fund	13,529	14,627
Kettering Award fund	2,476	2,461
TOTAL RESTRICTED FUND RESERVES	1,364,270	1,288,654
Operating Fund Reserve, Liabilities, Etc.:		
Accounts payable	139,936	123,469
Accrued expenses	1,993	2,133
Deferred income, etc.:		
Dues	62,080	57,240
Subscriptions to publications, etc.	81,740	57,906
Other	8,307	12,655
Reserve for expenses of moving to United Engineering Center	8,500	
Operating fund reserve (Exhibit B)	33,466	71,862
TOTAL OPERATING FUND RESERVE, LIABILITIES, ETC.	336,022	325,265
TOTAL	$1,965,308	$1,878,935

Exhibit B **Statement of Income and Operating Fund Reserve for the Years Ended April 30, 1961 and 1960**

	April 30, 1961	April 30, 1960
Income:		
Dues:		
Members	$ 908,216	$ 890,377
Students	44,727	45,618
	$ 952,943	$ 935,995
Fees:		
Entrance	$ 17,324	$ 18,089
Transfer	4,550	4,475
	$ 21,874	$ 22,564
Publications sales:		
Advertising	$ 339,551	$ 429,280
Electrical Engineering subscriptions, etc.	45,500	44,664
Transactions volumes	33,783	40,189
Bimonthlies subscriptions, etc.	92,137	79,380
Preprints, special and technical publications, etc.	85,168	117,717
	$ 596,139	$ 711,230
Other income:		
Meetings registration fees	$ 50,926	$ 51,243
Technical conferences—net	12,172	6,671
Income from investments:		
Reserve Capital Fund—Marketable securities	58,134	56,196
Other	2,883	2,958
Standards sales (including binders)	22,127	20,239
Sale of member emblems	250	471
Miscellaneous	2,568	2,032
	$ 149,060	$ 139,810
TOTAL INCOME	$1,720,016	$1,809,599
Expenses:		
General Administration Department:		
Public Relations	$ 60,830	$ 57,762
Sections	147,420	159,092
Student Branches	53,747	47,884
Membership	7,917	6,099
Institute Districts	6,313	8,892
Other (including salaries, 1961—$23,568; 1960—$25,358)	40,003	44,480
	$ 316,230	$ 324,209
Professional Development and Recognition Department	$ 18,541	$ 17,709
Technical Operations Department:		
Institute Meetings	$ 83,162	$ 73,583
Technical Activities	33,247	33,074
Standards Committee	18,256	21,687
Other	29,414	12,374
	$ 164,079	$ 140,718
Forward	$ 498,850	$ 482,636

	April 30, 1961	April 30, 1960
TOTAL INCOME (Forward)	$1,720,016	$1,809,599
EXPENSES (Forward)	$ 498,850	$ 482,636
Publications Department:		
Electrical Engineering:		
Advertising	$ 241,323	$ 255,614
Text	206,969	215,334
Transactions volumes	66,141	54,867
Bimonthlies	137,034	177,592
Membership directory and organization manual	10,032	17,690
Preprints, special and technical publications, etc.	100,162	121,605
	$ 761,661	$ 842,702
TOTAL DEPARTMENT EXPENSE	$1,260,511	$1,325,338
Non-Department Expense:		
General:		
Salaries	$ 218,022	$ 210,375
Postage	5,855	6,111
Stationery and supplies	12,851	14,136
Contributions under retirement plan	31,137	29,731
Social Security taxes	11,816	10,546
Legal fees	1,000	500
Travel expenses of Directors and President	10,485	16,122
Depreciation of equipment, etc., (including accelerated depreciation, 1961—$4,314;1960—$250)	12,693	6,687
United Engineering Trustees, Inc.:		
Building assessments, (exclusive of amounts charged to other accounts, 1961— $11,440; 1960—$11,056)	38,681	37,815
Library assessments and pension	31,412	30,706
Rental of equipment	8,693	12,297
Provision for moving expenses	8,500	—
Other	29,996	31,941
	$ 421,141	$ 406,967
Constitution and Bylaws Committee	1,592	2,499
Finance Committee	2,876	1,889
Planning and Coordination Committee	—	29
Intersociety Relations Committee	430	1,015
TOTAL NON-DEPARTMENT EXPENSE	$ 426,039	$ 412,399
TOTAL EXPENSE	$1,686,550	$1,737,737
Excess of Income over Expenses for the Year	$ 33,466	$ 71,862
Operating Fund Reserve, May 1	71,862	(65,934)
TOTAL	$ 105,328	$ 5,928
Transfer to Reserve Capital Fund	71,862	(65,934)
Operating Fund Reserve April 30	$ 33,466	$ 71,862

Exhibit C — Statement of Restricted Fund Reserves for the Year Ended April 30, 1961

	Total	Reserve Capital Fund	Member-for-Life Fund	International Electrical Congress of St. Louis Library Fund	Edison Medal Fund	Edison Endowment Fund	Lamme Medal Fund	Mailloux Fund	Volta Memorial Fund	Kettering Award Fund
Balance, May 1, 1960	$1,288,654†	$1,199,518	$35,301	$6,616	$11,552	$7,986	$9,539	$1,054	$14,627†	$2,461
Additions:										
Transfer from operating fund reserve (Exhibit B)	71,862	71,862								
Transfers between funds					155	(155)				
Income from investments	3,133	*	1,294	137	900	155	345	40	247	15
Dues paid by members-for-life	7,550		7,550							
Contributions	516		516							
TOTAL	1,371,715	1,271,380	44,661	6,753	12,607	7,986	9,884	1,094	14,874	2,476
Deductions:										
Purchase of medals, certificates, etc.	1,701		584		838		279			
Library purchases	177			137				40		
District branch prizes:										
Traveling expenses	3,415		3,415							
Prizes	464		464							
Scholarship awards	1,135								1,135	
Stationery, etc.	553		305		5		33		210	
TOTAL DEDUCTIONS	7,445		4,768	137	843		312	40	1,345	
Balance, April 30, 1961 (Exhibit A)	$1,364,270†	$1,271,380	$39,893	$6,616	$11,764	$7,986	$9,572	$1,054	$13,529†	$2,476
Composition of Balances:										
Securities (market value, $1,953,598)	$1,350,832	$1,270,617	$36,822	$5,031	$ 9,131	$7,828	$8,932		$11,330	$1,141
Cash in banks	13,438	763	3,071	1,585	2,633	158	640	$1,054	2,199	1,335
TOTAL	$1,364,270	$1,271,380	$39,893	$6,616	$11,764	$7,986	$9,572	$1,054	$13,529	$2,476

*The income of $58,134 from Reserve Capital Fund investments is credited to operating fund income (see Exhibit B).
†Balance at April 30, 1961 includes loan of $3,300 repayable to Operating Fund, like amount being included in accounts receivable subscriptions, etc. of latter fund.

Schedule of AIEE General and District Meetings

MEETING	DESIGNATION	NAME OF MEETING	CONVENTIONAL SCHEDULE	1962 DATE	1962 LOCATION	1962 PAPER CLOSING	1963 DATE	1963 LOCATION	1963 PAPER CLOSING	1964 DATE	1964 LOCATION	1964 PAPER CLOSING	1965 DATE	1965 LOCATION	1965 PAPER CLOSING	1966 DATE	1966 LOCATION	1966 PAPER CLOSING	INVITATIONS DATE	INVITATIONS LOCATION
GENERAL	WG	WINTER	FEB. 1ST WEEK	JAN. 28 FEB. 2	NEW YORK, N.Y.	OCT. 30 1961	JAN. 27 FEB. 1	NEW YORK, N.Y.	OCT. 29 1962	FEB. 2-7	NEW YORK, N.Y.	NOV. 4 1963	JAN. 31 FEB. 5	NEW YORK, N.Y.	NOV. 2 1964		NEW YORK, N.Y.			
	SG	SUMMER	JUNE 3RD 4TH WEEK	JUNE 17-22	DENVER, COLO.	MAR. 19 1962	JUNE 16-21	TORONTO, CANADA	MAR. 18	JUNE 21-26	LOS ANGELES, CALIF.	MAR. 23	JUNE 20-25	MIAMI, FLA.	MAR. 22				67 68	PORTLAND, OREGON MONTREAL, CANADA
	PG	PACIFIC	AUG.		SEE S.T.C. SCHEDULE		AUG. 20-23	SPOKANE, WASH.	MAY 23	JUNE 21-26	LOS ANGELES, CALIF.	MAR. 23	AUG. 31 SEPT. 3	VICTORIA, B.C.	JUNE 1		PHOENIX, ARIZ.		67	PORTLAND, ORE.
	FG	FALL	OCT.	OCT. 7-12	CHICAGO, ILL.	JUNE 8	OCT. 6-11	CHICAGO, ILL.	JUNE 7	OCT. 4-9	HOUSTON, TEXAS	JUNE 5		CHICAGO, ILL.			CHICAGO, ILL.			
DISTRICT	DI	EMPIRE	EARLY MAY	MAY 14-16	ERIE, PA. JOINT WITH DII & DI4	FEB. 13														
	D2	MIDDLE EASTERN	MAY	MAY 7-9	WILMINGTON, DEL.	FEB. 8														
	D4	SOUTH EAST	LATE MAR. EARLY APR.				APR. 24-26	RICHMOND, VA. JOINT WITH DI3	JAN. 24											
	D5	GREAT LAKES	LATE APR.	APR. 18-20	FORT WAYNE, IND.	JAN. 19 1962	MAY 1-3	QUAD-CITIES	JAN. 31	APR. 22-24	PEORIA, ILL.	JAN. 23								
	D7	MID-AMERICA	LATE MAR. EARLY APR.	APR. 30 MAY 2	ST. LOUIS, MO.	JAN. 30														
	DII	EAST CENTRAL	EARLY MAY	MAY 14-18	ERIE, PA. JOINT WITH DI & DI4	FEB. 13	MAY 8-10	TOLEDO, OHIO JOINT WITH DI4	FEB. 7		PITTSBURGH, PA. JOINT WITH DI4			CINCINNATI OR COLUMBUS, O. WITH DI4			DAYTON, OHIO			
	DI2	NORTH EASTERN	LATE APR. EARLY MAY	MAY 9-11	BOSTON, MASS.	FEB. 8 1962	MAY 14-17	PORTSMOUTH, N.H.	FEB. 13	APR. 27-29	WORCESTER, MASS.	JAN 28	APR. 26-28	PITTSFIELD, MASS	JAN. 26	APR 25-27	SPRINGFIELD, MASS.	JAN. 25		
	DI3	SOUTH CENTRAL	LATE MAR. EARLY APR.	APR. 4-6	MEMPHIS, TENN.	JAN 4 1962	APR. 24-26	JOINT WITH D4 RICHMOND, VA.	JAN. 24	APR. 1-3	BIRMINGHAM, ALA.	JAN. 2								
	DI4	ALLEGHENY-OHIO VALLEY	APR. OR MAY	MAY 14-15	ERIE, PA. JOINT WITH DI & DII	FEB. 13	MAY 8-10	TOLEDO, OHIO JOINT WITH DII	FEB. 7		PITTSBURGH, PA. JOINT WITH DII			CINCINNATI OR COLUMBUS, O. WITH DII						
EASTER				APRIL 22			APRIL 14			MARCH 29			APRIL 18			APRIL 10				

The AIEE Dollars

1960-61

WHERE THEY CAME FROM

Dues, Entrance, Transfer Fees	$ 974,817
Advertising	339,551
Bimonthlies Subscriptions, Preprints, Special and Technical Publications	177,305
Electrical Engineering Subscriptions	45,500
Transactions	33,783
Interest and Dividends	61,017
Meeting Registration Fees	50,926
Standards Sales	22,127
Technical Conferences	12,172
Miscellaneous	2,818
Total Income, General Fund	$1,720,016
Plus Income From Special Funds Allocated to 1960-61 Expenses	7,446
	$1,727,462

WHERE THEY WENT

Publication Services	$ 912,349
Section Allotments and Services	190,239
Student Services	150,583
Headquarters Building & Equipment (including library)	116,514
Institute Meetings	113,564
Technical Activities, including Standards	97,566
Membership Development and Selection	69,051
Support of Inter-society Affiliations	31,386
Professional Development and Recognition	12,744
	$1,693,996

Prepared by Public Relations Committee

1960-61 OFFICERS

PRESIDENT
C. H. LINDER
(Term expires July 31, 1961)

PAST-PRESIDENTS

L. F. HICKERNELL
(Term expires July 31, 1961)

J. H. FOOTE
(Term expires July 31, 1962)

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E. W. MORRIS
J. C. STRASBOURGER
(Terms expire July 31, 1961)

HENDLEY BLACKMON
E. I. GREEN
S. M. OSTHAGEN
(Terms expire July 31, 1963)

W. A. LEWIS
N. F. RODE
E. C. STARR
(Terms expire July 31, 1962)

R. B. GEAR
C. T. HATCHER
C. T. PEARCE
(Terms expire July 31, 1964)

DEPARTMENT DIRECTORS

General Administration
C. T. PEARCE

Professional Development and Recognition
B. G. A. SKROTZKI

Publications
W. F. DENKHAUS
(Terms expire July 31, 1961)

Technical Operations
F. L. LAWTON
(Terms expire July 31, 1962)

DISTRICT VICE-PRESIDENTS

District
1 C. E. GAYLORD
3 R. T. WEIL, JR.
5 F. W. BUSH
7 S. C. WRIGHT
9 H. A. CARLBERG
11 A. W. RAUTH
13 WALTER CRILEY
15 P. G. WALLACE
(Terms expire July 31, 1962)

District
2 H. H. SHEPPARD
4 J. W. DAVIS
6 M. H. KIGHT
8 G. T. HARNESS
10 RENE DUPUIS
12 F. S. BACON, JR.
14 W. H. CHASE
(Terms expire July 31, 1961)

TECHNICAL VICE-PRESIDENTS

Communication Division
F. B. BRAMHALL

Industry Division
J. F. DEFFENBAUGH

General Applications Division
L. R. LARSON

Instrumentation Division
P. K. McELROY

Power Division
J. H. KINGHORN
(Terms expire July 31, 1961)

Science and Electronics Division
E. L. HARDER
(Terms expire July 31, 1962)

TREASURER

W. R. CLARK
(Term expires July 31, 1961)

EXECUTIVE SECRETARY

N. S. HIBSHMAN
(Term expires July 31, 1961)

American Institute of Electrical Engineers, 33 West 39th Street, New York 18, N. Y.

INSTITUTE ACTIVITIES

ONE of the most modern integrated steel-making facilities in the United States is the Geneva Works of the United States Steel Corporation, Columbia-Geneva Division. An inspection trip will be made to this division during the Pacific General Meeting on Thursday, August 24, at 9:00 a.m.

50th Annual Pacific General Meeting To Be Held August 23-25 in Salt Lake City

THE 50th annual Pacific General Meeting of AIEE will feature the presentation of 61 technical papers. Registration will commence at 5:00 p.m. on Tuesday, August 22, at the Hotel Utah in Salt Lake City, Utah, and activities will wind up on Friday, August 25. The technical sessions are being arranged by the Technical Operations Department of the Institute and will list papers on subject matter matching the large technical diversity of Utah industry. In the greater Salt Lake Valley there are industries varying from mining and its associated phases to manufacture and assembly of space age electronics and missiles equipment.

Utah people are noted for their friendliness and hospitality, and Salt Lake City is the center of scenic America. It is 305 miles by car to Jackson Hole, Wyoming and Yellowstone National Park, 127 miles to the famous Salt Flats, 400 miles to the Grand Canyon, 266 miles to Cedar Breaks National Monument, and 275 miles to Bryce Canyon. The roads are good and the speed limit is 60 miles per hour.

M. A. Bostwick, chairman of the Pacific Coast Relay Subcommittee, is scheduling a full day of discussions on relaying problems for Tuesday, August 22. These discussions will be open to members as well as the subcommittee. For further information Mr. Bostwick may be contacted at the Portland General Electric Company, Portland, Ore.

Inspection Trips

Matching the diversity of Utah industry, inspection trips have been arranged as follows:

Wednesday, August 23 (1:30 p.m.) Kennecott Copper Corporation. This corporation operates complete mining, milling, smelting, and refining facilities only 25 miles from downtown Salt Lake City. The corporation's Bingham Canyon mine is generally acknowledged as the world's largest man-made excavation from which are produced nearly a half billion pounds of copper every year. Nearby at Magna, Utah, is the largest copper smelter in the world and a short distance from there is the electrolytic refinery. The facilities in Utah produce about 22% of the nation's newly mined copper every year. The processing of this low-grade copper ore is a high engineering achievement. Cost for this trip will be for transportation only, approximately $1.50.

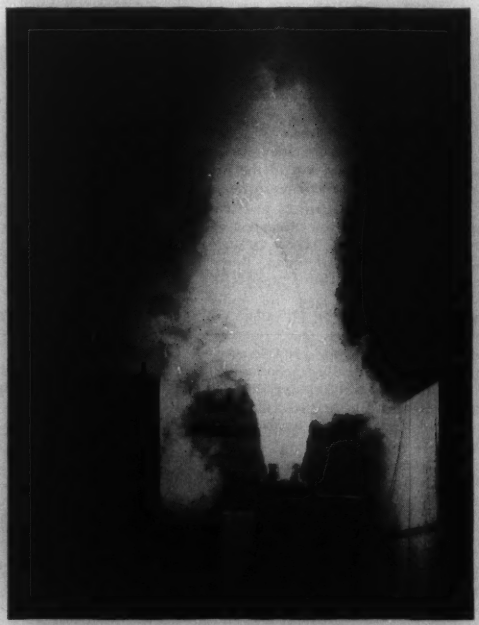
Thursday, August 24 (9:00 a.m.) United States Steel Corporation. The corporation's Columbia-Geneva Steel Division operates the most highly integrated steel mill west of the Mississippi River at Geneva, Utah. This facility was built in early 1940 and hence is a most modern steel facility. Since that day, it has been continually expanded and modernized.

Thursday, August 24 (1:00 p.m.) Hercules Powder Company. At Bacchus, Utah, not far from the Bingham Canyon mine, the Hercules Powder Company has a long-established explosives plant. This facility is being expanded to cover work which is being performed by the company on the third stage of the Minute Man Missile and the second stage of the A2 Polaris Missile. Cost of this inspection trip will be approximately $1.50 for transportation only.

Social Events

A welcoming cocktail party is planned for the hours of 6:00 and 8:00 p.m. on Tuesday, August 22. On Wednesday, the Lafayette Ball Room of the Hotel Utah will be the location for the welcoming luncheon where the featured speaker will be Dr. C. S. Winters of the General Motors Corporation.

On Thursday, August 24, the main banquet will be held in the Hotel Utah with a cocktail hour preceding the banquet. Entertainment will be provided after the banquet.



BRILLIANT glare erases part of the night skies around the Hercules Powder Company's Bacchus rocket plant, and a sustained roar heard for miles announces static firing of an Air Force third stage Minuteman engine from the test bay. This facility will be visited Thursday, August 24, at 9:00 a.m., during the Pacific General Meeting.

Tentative Schedule of Events

August 22, Tuesday

Registration Begins, 5:00 p.m.

Cocktail Party, 6:00 p.m.

August 23, Wednesday

Technical Sessions, 9:00 a.m.
Reactor Instrumentation Systems
Mining
Relays

Ladies' Hunt Breakfast, 10:00 a.m.

Men's Luncheon, 12:00 noon

Kennecott Copper Corp. Trip, 1:30 p.m.

Technical Sessions, 2:00 p.m.
Chemical Industry
Substations
Electrical Instruments in Biology

August 24, Thursday

United States Steel Corp. Trip, 9:00 a.m.

Technical Session, 9:00 a.m.
Residential Electric Heating
Industrial and Commercial Power Systems
Wire Communications
Materials Handling & Construction Industry

Ladies' Coffee Hour, 9:00 a.m.

Ladies' Luncheon & Fashion Show, 1:00 p.m.

Hercules Powder Co. Trip, 1:00 p.m.

Technical Sessions, 2:00 p.m.
Industrial and Commercial Power Systems
System Planning and Economics
Radio Communications
Solid State Devices

Main Banquet, 6:00 p.m.

August 25, Friday

Ladies' Coffee Hour, 9:00 a.m.

Technical Sessions, 9:00 a.m.
Broadcasting
Transmission and Distribution
Feedback Control Systems

Ladies' Events

Ladies will register Tuesday, August 22, at 5:00 p.m., and may attend the welcoming cocktail party at 6:00 p.m.

On Wednesday, August 23, at 10:00 a.m., they will have a Hunt Breakfast at Log Haven. Bridge and flower arranging is scheduled for the afternoon. Buses and cars will be provided for transportation.

The ladies will meet for coffee on Thursday, August 24, at 9:00 a.m. at Hotel Utah. At 1:00 p.m., they will be taken to the Fort Douglas Hidden Valley Country Club for a luncheon and fashion show. Cocktails will be served at 6:00 p.m. at the Hotel Utah. At 7:00 p.m., the ladies will accompany their husbands to the banquet.

On Friday, August 25, at 9:00 a.m., the ladies will meet again for coffee at the Hotel Utah.

Student Activities

Student activities are being arranged by Dr. L. D. Harris of the University of Utah for Thursday, August 24. There will be meetings in the afternoon for students and counselors to discuss problems of mutual interest. The luncheon on Thursday for students and their counselors will feature a speaker presenting a topic of interest to all participants.

Sports

Arrangements have been completed with the Salt Lake Country Club whereby AIEE members registered at the meeting will be able to utilize the recreational facilities of the club. Individuals will have to make their own arrangements as to swimming, tennis, and golf at the Country Club.

Hotel Reservations

Hotel and motel accommodations are available in both downtown Salt Lake City and in the suburbs.

Hotel rates are as follows:

Hotel Utah			
Single Room	$ 8.00	to	$15.00
Double Room	10.00	to	18.00
Twin Room	12.00	to	18.00
Two-room Suites	20.00	to	35.00
World Motor Hotel			
Single Room	$ 8.00	to	$10.00
Double Bedroom	12.00	to	16.00
Suites	14.00	to	18.00
Hotel Utah Motor Lodge			
Single Room	$ 9.00	to	$12.00
Double Room	12.00	to	16.00
Twin Room	14.00	to	16.00
Temple Square Hotel			
Single Room	$ 5.00	to	$ 7.50
Double Room	7.50	to	9.50
Twin Room	8.00	to	11.00

Free parking.

The Hotel and Facilities Committee will handle reservations on a first-come first-served basis. F. O. Wald, chairman of the committee, may be contacted for information and reservations at the Utah Power and Light Company, Box 899, Salt Lake City, Utah.

Registration

The registration desk will be located on the mezzanine of the Hotel Utah. Facilities for registering will be available Tuesday beginning at 5:00 p.m. and continuing daily throughout the meeting.

For convenience, members and nonmembers should return their advance registration cards. Registration fees payable at the meeting are $6 for members, $10 for nonmembers, and $2 for ladies. Children and students will not be charged a fee.

Technical Program Given

The tentative technical program follows:

Wednesday, August 23

9:00 a.m.—Reactor Instrumentation Systems

CP.* The Design of Nuclear Instrumentation Systems for Water Cooled Reactor Power Plants. *R. Eastman, S. N. Ehrenpreis,* Westinghouse Elec. Corp.

CP61-929. Design and Performance of the Dresden Station In-Core Monitor System. *R. K. Baird, J. Forster,* General Elec. Co.

CP61-951. Instrumenting a Sodium Cooled Reactor Power Plant for Control and Safety. *E. Matlin,* Atomics Int'l.

CP61-950. Automation Study of a Nuclear Propulsion System. *R. B. Rice,* General Elec. Co.

9:00 a.m.—Mining

CP.* A.C. Motors & Controls As Applied to Loading Machines. *B. Harbage,* Jeffrey Mfg. Co.

CP.* Semi-Conductor Control for Excavating Equipment. *A. M. Vance,* Westinghouse Elec. Corp.

CP.* Electric Drive for Off-Highway Vehicles. *H. J. McLean, H. Vitt,* General Elec. Co.

9:00 a.m.—Relays

61-925. Transient Voltages in Relay Control Circuits. *W.K. Sonnemann,* Westinghouse Elec. Corp.

61-936. Protection of Control Circuit Rectifiers Against Surges from D-C Coil Interruption. *H. T. Seeley,* General Elec. Co.

61-935. A Static Voltage Differential Relay for Protection of Shunt Capacitors. *M. O. Tom,* Bonneville Power Admin.

61-921. A Partial Survey of Relay Protection of Steam Driven A-C Generators. AIEE Working Group of the Generator Protection Subcommittee of the Relays Committee, J. M. Bisbee, chairman

2:00 p.m.—Chemical Industry

61-944. Committee Report on Electrical Characteristics of Electro-chemical Cell Line. AIEE W.G. of the Electro-chemical Process Sub. of the Chemical Industry Committee, R. P. Stratford, chairman (Re-presented for Discussion only)

CP.* Protection of Three Phase Motors Against Single Phasing. *R. H. Long*

CP.* The 1960 Extension to the Inspiration Electrolytic Tank House, *R. E. Martin, C. E. Helms,* Inspiration Consolidated Copper Co.

2:00 p.m.—Substations

CP.* Short Circuit Tests on Strain Buses. *R. S. Melville,* Southern Calif. Edison Co.

CP61-926. Considerations in Purchasing Mobile Substations. *R. H. Schneider,* Tacoma, Wash.

CP.* Transformer Noise Problems on Substations. *E. H. Wendt,* Los Angeles Dept. of Water and Power.

2:00 p.m.—Electrical Instruments in Biology

CP61-943. Electrical Techniques and the Heart in Health and Disease. *G. G. Knickerbocker, W. B. Kouwenhoven,* Johns Hopkins Univ.

CP.* Electronics, Plumbing and Last-Chance Cardiology. *C. T. Dotter,* Univ. of Oregon.

* Conference papers will not be reprinted by the Institute; however, they may be available at the meeting at the discretion of the author.

PREPRINT PRICES

50¢ to Members.
$1.00 to Nonmembers.

ALL MAIL ORDERS must be accompanied by remittance in full or coupons.

COUPON BOOKS in $10 denominations may be purchased.

NUMBERED PAPERS only are available.

SEND ORDER and remittance to:
AIEE Order Department
33 West 39th Street
New York 18, N. Y.

Thursday, August 24

9:00 a.m.—Residential Electric Heating

CP.* Investigation and Test of Grounding Method for Residential Installations. *H. G. Ufer*

CP.* Conductor Sizing for Electric Heating Loads. *F. O. Wald, R. S. Patrick*, Utah Power & Light Co.

CP.* Higher Service Voltage for Future Residential Loads. *A. S. Anderson*, Ebasco Services

CP.* Review of Shock Hazards at Higher Residential Utilization Voltage

9:00 a.m.—Industrial and Commercial Power Systems

CP.* Power System Design for a Modern Electrolytic Copper Refinery. *D. T. Young*, Kenneeott Copper Corp.

CP.* Plant Electrical Engineering in the U.S. Army Chemical Corps. *D. Kamoroff*, U.S. Army Chemical Corps

CP.* Power Distribution and Supervisory Control for a Gas Compressor Plant. *P. Belsky*, Westinghouse Elec. Corp.

9:00 a.m.—Wire Communications

61-945. Synthesis of Networks Simulating Impedance of Loaded Cable Facilities. *R. W. DeMonte*, Bell Tel. Labs.

CP61-946. Plug-In Span Pad and Artificial Line Units for Use on N & On Carrier. *J. M. Ridd*, Pacific Tel. & Tel. Co.

CP61-947. New Problems in Transmission Maintenance and Their Effect on Equipment Design Concepts Test. *E. H. B. Bartelink*, Northeast Electronics Corp.

CP.* Making the Three-Channel Stackable Carrier Meet Present Day Transmission Requirements. *R. R. Ashman, L. B. Johnson*, Lenkurt Elec. Co.

CP.* Applications of a New 600 Channel Multiplexing System for Microwave. *E. E. Combs, C. A. Kirkwood*, Lynch Communication Systems

9:00 a.m.—Materials Handling & Construction Industry

CP.* Atlas Launcher Platform Drive System. *A. S. Bishay*, Amer. Machine & Foundry Co.; *L. R. Foote*, General Elec. Co.

CP.* Electrification of Concrete Handling Equipment for Projects Construction. *H. V. Nelson, B. F. Bennett*, General Elec. Co.

9:00 a.m.—Reactor Operation

CP61-930. Control and Transient Performance of the Dresden Nuclear Power Station. *W. I. Collett, E. R. Owen*, General Elec. Co.

CP61-931. A Combined Nuclear and Coal Fired Power Plant—HNPF. *C. L. Dunsmore*, Atomics Int'l.

CP.* Transient Performance of the Yankee Atomic Electric Power Plant. *J. M. Gallagher*, Westinghouse Elec. Corp.

CP.* A Transistorized Radiation Pulse Amplifier. *L. D. Test, H. H. Hendon*, General Elec. Co.

2:00 p.m.—Industrial and Commercial Power Systems

CP61-949. Electrical Design Features of a New High-Rise Office Building. *J. P. Kesler, B. J. Stables*, Black & Veatch

CP61-933. A Computer Approach to Setting Directional Overcurrent Relays on Industrial Network Type Systems. *A. H. Knable*, Allis-Chalmers Mfg. Co.

CP.* High Continuity Industrial Power Distribution with Metalclad Load Interrupter Switchgear. *J. B. Castle*, S & C Elec. Co.

2:00 p.m.—System Planning and Economics

60-1201. Optimized Transmission Tower Spotting on Digital Computer. *V. Converti, E. J. Hyland, D. E. Tickle*, Ariz. Public Service Co. (Re-presented for Discussion only)

61-932. Short-Circuit Comparison Study. *R. B. Shipley, D. Coleman, W. L. Nason*, TVA

CP61-922. High-Voltage Power System Decrements. *M. J. Lantz*, Bonneville Power Admin.

CP61-924. Estimating Appliance Consumption in Distribution Systems. *T. A. Lambe, J. C. Clapham*, Univ. of British Columbia

61-923. A Note on the Capital Recovery Factor. *J. F. Brennan*, Pacific Gas & Elec. Co.

2:00 p.m.—Radio Communication

CP.* Very Long Traveling Wave Antennas. *D. K. Reynolds*, Univ. of Wash.

CP61-928. Mobile Radio Test Laboratory. *N. L. Brotzman*, Pacific Tel. & Tel. Co.

CP.* An Analysis of Simultaneous Use of Mobile Telephone Systems for One Way Signalling. *C. A. Rypinski*, Secode Corp.; *D. L. MacDonald*, Pacific Tel. & Tel. Co.

61-927. Design of a 2-Way Radio Channel for Maintenance of Telephone Company Services. *D. L. MacDonald*, Pacific Tel. & Tel. Co.

61-920. Remote Outage Location by Means of VHF Radio Systems. *M. Cooper*, Motorola (Re-presented for Discussion only)

60-1280. Noise-Loading Test of a Complete Frequency-Division Multiplex Voice Point-to-Point Communication System. *L. P. Yeh*, Page Communications Engineers (Re-presented for Discussion only)

2:00 p.m.—Solid State Devices

CP.* The Simulation of Solar Radiation. *D. Bickler*, Hoffman Electronics Corp.

CP.* Cryotrons—State of the Art. *J. Bremer*, General Elec. Co.

Friday, August 25

9:00 a.m.—Broadcasting

CP.* Auxiliary Television Broadcast Services. *A. Taylor*, Univ. of Mont.

CP.* New Recommendations Affecting TV Allocations. *J. Barr*, FCC

CP.* Developing a State-Wide Educational UHF TV Network. *O. Reed, Jr.*, Jansky & Bailey

9:00 a.m.—Transmission & Distribution

CP61-940. Aluminum Cold Flow Compensation in Bolted Electrical Connections. *G. L. Flynn, T. L. Rundlett*, Anderson Elec. Corp.

61-941. Unbalanced Open Conductors in Power Systems. *N. Seiseth*, Univ. of Mich.

CP.* The NEAR System—Disaster Warning Via the Utility Network. *R. I. Kopan*, Midwest Research Inst.

61-942. The Effect of Negative Corona Upon the Formation of Positive Corona. *G. A. Pearson*, Berkeley, Calif.

9:00 a.m.—Feedback Control Systems

61-952. Improving the Linearity of the Steady State Gain Characteristic by Use of Nonlinear Feedback. *N. E. Nahi*, Univ. of Southern Calif.; *S. Plotkin*, Hoffman Electronics Corp.

CP61-937. Subharmonic Oscillations in On-Off Control Systems. *J. C. Gille*, Ecole Nationalie Supérieure De L'Aéronautique; *J. G. Paquet*, Université Laval

CP61-938. Construction of the Lyapunov Function for Asymptotic Stability Via the Quadratic Form. *L. K. Timothy*, Autonetics

CP61-939. Discontinuous Automatic Control: Some Theoretical Considerations. *G. J. Thaler, K. W. Han*, U. S. Naval Postgraduate School

The members of the 1961 Pacific General Meeting Committee are H. B. Hodgins, general chairman; R. A. Radford, co-chairman; J. A. McDonald, treasurer; J. N. Jones, secretary; F. C. Bates, Finance, Registration and Paper Sales; R. K. Bertoch, Program; V. E. Clayton, Publicity; Mrs. P. G. Morse, Ladies Activities; P. G. Morse, Hospitality, Trips, Sports; J. D. Stephens, Entertainment; R. E. Stephenson, Student Activities; and F. O. Wald, Hotel Facilities.

Conference Papers Open for Discussion

Conference papers listed below have been accepted by AIEE *Transactions* and are now open for written discussion until August 28. Duplicate double-spaced typewritten copies of each discussion should be sent to E. C. Day, Assistant Secretary for Technical Papers, AIEE, 33 W. 39th St., New York 18, N. Y., on or before August 28.

56-83 **Analysis of the Shading Coil Magnet.** *H. J. Kubiak* (Preprint unavailable)

60-1007 **A Computer Program for Preparing Wiring Diagrams.** *Mrs. D. B. Kirby, C. W. Rosenthal*

60-1028 **The Effect of Variable Plasma Conductivity on MHD Energy Converter Performance.** *W. B. Coe, C. L. Eisen*

60-1033 **Magneto-Thermionic Power Generation.** *A. Schock*

60-1066 **Thermoelectricity Application Considerations.** *A. A. Sorensen*

60-1280 **Noise-Loading Test of a Complete Frequency-Division Multiplex Voice Point-to-Point Communication System.** *L. P. Yeh*

61-31 **Aluminum Conduit Use in the Hydrocarbon and Chemical Process Industries.** *Henry Esch, R. P. Brown*

61-186 **Accuracy in Process Computer Instrumentation Systems.** *W. M. Gaines, W. N. Patterson*

61-646 **Computer Solutions to Nuclear Ice-Breaker Propulsion Problems.** *G. F. Rodgers*

61-650 **Characteristics of a Synchronous Inductor Motor.** *A. E. Snowdon, E. W. Madsen*

61-653 **Loop-Around Transmission Test Circuit for Step-by-Step CDO's Having Verification Train.** *F. O. Richardson, J. J. Clark*

61-776 **The 81-A Exchange Trunk Carrier System—Signaling.** *E. F. Tuck, D. K. Melvin*

Preprints may be purchased at 50¢ each to members, $1.00 to nonmembers, if accompanied by remittance or coupons. Please order by number and send remittance to: AIEE Order Department, 33 W. 39th St., New York 18, N.Y.

AIEE Future Meetings

Pacific General Meeting*
Hotel Utah
Salt Lake City, Utah
August 23-25, 1961

AIEE-IRE-ISA Joint Nuclear Instrumentation Conference*
North Carolina State College
Raleigh, N. C.
September 6-8, 1961

AIEE-ASME Engineering Management Conference*
Hotel Roosevelt
New York, N. Y.
September 14-15, 1961

Petroleum Industry Conference*
Jung Hotel
New Orleans, La.
September 17-20, 1961

AIEE-ISA-IRE Industrial Electronics Conference*
Bradford Hotel
Boston, Mass.
September 20-21, 1961

AIEE-ASME National Power Conference*
St. Francis Hotel
San Francisco, Calif.
September 24-27, 1961

Middle Atlantic (Fall) Textile Conference
Barringer Hotel
Charlotte, N. C.
October 5-6, 1961
(Final date for †TP—closed, ‡CP Syn.—Aug. 4, CPMs—Aug. 15)

AIEE-IRE-EIA-SMPTE National Electronics Conference
Sherman Hotel
Chicago, Ill.
October 9-11, 1961
(Final date for †TP—closed, ‡CP Syn.—closed, CPMs—Aug. 4)

Fall General Meeting
Statler-Hilton Hotel
Detroit, Mich.
October 15-20, 1961
(Final date for †TP—closed, ‡CP Syn.—closed, CPMs—Aug. 11)

Machine Tools Conference
Faust Hotel
Rockford, Ill.
October 16-18, 1961
(Final date for †TP—closed, ‡CP Syn.—Aug. 2, CPMs—Aug. 11)

AIEE-IRE-U of Nebr. Biomedical Instrumentation and Engineering Conference
Sheraton-Fontenelle Hotel
Omaha, Nebr.
October 26-27, 1961
(Final date for †TP—closed, ‡CP Syn.—Aug. 11, CPMs—Aug. 22)

Western Appliance Conference
Biltmore Hotel
Los Angeles, Calif.
November 6, 1961
(Final date for †TP—Aug. 8, ‡CP Syn.—Aug. 23, CPMs—Sept. 1)

NOTICE TO AUTHORS

Strict compliance with the "Author's Guide" will save you time, delays, and unnecessary correspondence. For a copy, write to E. C. Day, 33 West 39 St., New York 18, N.Y.

AIEE-IRE Nonlinear Magnetics Conference
Statler-Hilton Hotel
Los Angeles, Calif.
November 6-8, 1961
(Final date for †TP—Aug. 8, ‡CP Syn.—Aug. 23, CPMs—Sept. 1)

AIEE-AIP Magnetism and Magnetic Materials Conference
Westward Ho Hotel
Phoenix, Ariz.
November 12-16, 1961
(Final date for †TP—Aug. 14, ‡CP Syn.—Aug. 29, CPMs—Sept. 8)

AIEE-IRE-ACM Eastern Joint Computer Conference
Sheraton-Park Hotel
Washington, D. C.
December 10-14, 1961
(Final date for †TP—Sept. 11, ‡CP Syn.—Sept. 26, CPMs—Oct. 6)

AIEE-IRE-ASQC National Symposium on Reliability Control
Statler Hilton Hotel
Washington, D. C.
January 9-11, 1962
(Final date for †TP—Oct. 11, ‡CP Syn.—Oct. 26, CPMs—Nov. 6)

Winter General Meeting
Hotel Statler
New York, N. Y.
January 28-February 2, 1962
(Final date for †TP—Oct. 30, ‡CP Syn.—Nov. 9, CPMs—Nov. 24)

AIEE-IRE-U of P International Solid-State Circuits Conference
University of Pennsylvania
and Sheraton Hotel
Philadelphia, Pa.
February 15-16, 1962
(Final date for †TP—Nov. 17, ‡CP Syn.—Dec. 8, CPMs—Dec. 19)

AIEE-IRE-AEC-NBS 8th Scintillation and Semi-Counter Conference
Shoreham Hotel
Washington, D. C.
March 1-2, 1962
(Final date for †TP—Dec. 1, ‡CP Syn.—Dec. 15, CPMs—Dec. 26)

Cement Industry Conference
St. Louis, Mo.
April 3-5, 1962
(Final date for †TP—Jan. 3, ‡CP Syn.—Jan. 18, CPMs—Jan. 29)

South Central District Meeting
Hotel Peabody
Memphis, Tenn.
April 4-6, 1962
(Final date for †TP—Jan. 4, DPMs —Jan. 29)

Rubber and Plastics Industries Conference
Sheraton Hotel
Akron, Ohio
April 9-10, 1962
(Final date for †TP—Jan. 9, ‡CP Syn.—Jan. 24, CPMs—Feb. 2)

Great Lakes District Meeting
Hotel Van Orman
Fort Wayne, Ind.
April 18-20, 1962
(Final date for †TP—Jan. 18, DPMs —Feb. 9)

Mid-America District Meeting
Hotel Chase
St. Louis, Mo.
April 30-May 2, 1962
(Final date for †TP—Jan. 30, DPMs —Feb. 23)

Middle Eastern District Meeting
Hotel DuPont
Wilmington, Del.
May 7-9, 1962
(Final date for †TP—Feb. 6, DPMs —Mar. 2)

North Eastern District Meeting
Hotel Statler
Boston, Mass.
May 9-11, 1962
(Final date for †TP—Feb. 8, DPMs —Mar. 5)

Joint District Meeting
Erie, Pa.
May 14-16, 1962
(Final date for †TP—Feb. 13, DPMs —Mar. 9)

AIEE-ISA-ARS-IAS National Telemetering Conference
Sheraton-Park Hotel
Washington, D. C.
May 23-25, 1962
(Final date for †TP—Feb. 22, ‡CP Syn.—Mar. 9, CPMs—Mar. 19)

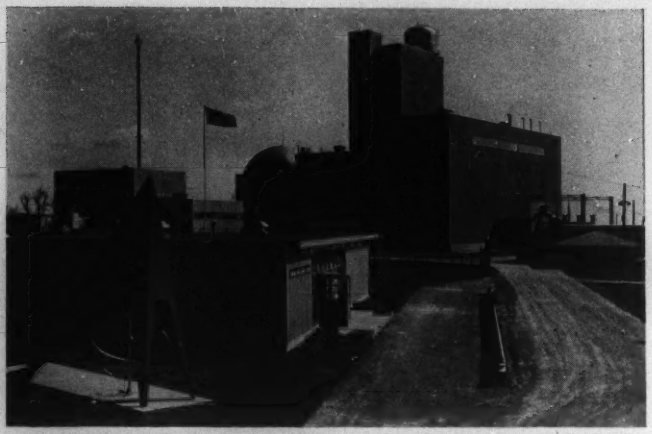
Summer General Meeting
Hotel Denver Hilton
Denver, Colo.
June 17-22, 1962
(Final date for †TP—Mar. 19, CPMs —April 11)

AIEE-AIChE-IRE-ISA-ASME Joint Automatic Control Conference
New York University
New York, N. Y.
June 27-29, 1962
(Final date for †TP—Mar. 29, ‡CP Syn.—April 13, CPMs—April 23)

IFIPS Congress
Munich, Germany
August 27-September 1, 1962
(Abstracts due Sept. 15)

*Final date for submitting papers—closed

†TP—Transactions Paper
‡CP Syn.—Conference Synopsis
CPMs—Conference Manuscript
DPMs—District Manuscript
(District Paper Synopses should be directed to the District Meeting Committee)



WORLD'S largest "breeder" power reactor installation, the Enrico Fermi Atomic Power Plant, will be viewed October 18 on an inspection trip during the Fall General Meeting in Detroit.

AIEE Fall General Meeting Scheduled for October 15-20, 1961, in Detroit, Mich.

THE 1961 Fall General Meeting of AIEE will be held October 15-20 at the Statler-Hilton Hotel in Detroit, Mich.

Inspection Trips Planned

For this meeting, nine inspection trips have been arranged as follows:

Enrico Fermi Atomic Power Plant. Capable of generating 100,000 kw when completed late in 1961, the Enrico Fermi Plant will cost approximately $85 million. The atomic plant, as a result of its "breeder-type" characteristic will actually produce about 20% more fuel in the form of plutonium, Pu-239, than it consumes in the form of U-235, fissionable uranium. This inspection trip will take place on Wednesday, October 18.

Michigan Bell Telephone Company Data-Processing Center. This installation is one of the largest data-processing centers in service. Final products of the processing include mundane items such as payroll, paydrafts, reports, customers' bills and also "cloud nine" items too confidential to divulge. The installation is scheduled for Tuesday, October 17.

Ford Motor Company — Rouge Plant. This huge manufacturing plant on the banks of the Rouge River is the largest concentration of closely knit integrated factories owned by one company in America. Three blast furnaces smelter 4,000 tons of iron a day. Ten open-hearth furnaces and the mill, with an ingot capacity of 1,940,000 tons a year, turn out steel for automobiles. The Rouge generates its own electricity, manufactures its own coke, and generates its own oxygen and nitrogen for the blast furnaces and steel mill operations. New cars are drawn away from its final assembly line at the rate of one every 48 seconds. An inspection trip to this plant is planned for Monday, October 16.

National Bank of Detroit. Among the many unique features of the National Bank of Detroit Main Office Building is a pneumatic-tube system wherein one mile of tubing carries mail, items, and memoranda to and from strategically located stations throughout the building. This building also has the monitoring and control console from which one man controls most of the mechanical services of the building, including 83 controls, 129 monitoring indicators, and 19 alarm signals. The inspection trip will be held Wednesday, October 18.

Chrysler Corporation Lynch Road Plymouth Plant. The Detroit Plymouth Plant assembly line is 18,272 feet long; it performs 737 different operations to build each automobile and has a capacity of 68 cars per hour. This inspection trip will be held on Thursday, October 19.

General Motors Technical Center. The General Motors Technical Center includes some 28 buildings and a 22-acre lake in an area of one square mile which serves as the work location for some 20,000 technical people providing up-to-date facilities for research, styling, engineering, and manufacturing development of General Motors' products. An inspection trip to the Technical Center will take place on Tuesday, October 17.

Detroit's New Post Office. Modern in every respect, Detroit's new post office handles two thirds of the approximate 5 million pieces of mail flowing daily through Detroit. Letter scanners, letter sorters, 20 miles of conveyors, and a memory drum which "remembers" conveyor destinations and is the brains of the system make up this automated marvel of electronic efficiency. An inspection trip will be held here on Thursday, October 19.

International Salt Company. A large portion of Detroit rests atop one of the greatest concentrations of rock salt anywhere. An inspection trip is scheduled for Wednesday, October 18, to tour one of the mines of the International Salt Company located within the city limits of Detroit.

Phoenix Memorial Laboratory. At the Phoenix Memorial Laboratory on the North Campus of the University of Michigan at Ann Arbor, radiation effects on biological and botanical specimens are observed. The reactor will be in operation and experiments and studies under way at the time of this trip on Thursday, October 19.

Ladies' Activities

The AIEE ladies who attend the Fall General Meeting will enjoy a busy week of interesting activities planned by Mrs. R. E. Bradstrum, and co-chairmen Mrs. A. P. Fugill and Mrs. H. M. Hess. A wel-

THE solid-state 7070 computer is the backbone of the Michigan Bell Telephone Company's Data-Processing Center. An inspection trip to this installation is scheduled to be held during the Fall General Meeting.

coming reception will be given at 4:00 p.m. in the Wayne Room of the Statler Hotel on Sunday, October 15, for members, their wives, and guests.

On Monday, October 16, sightseeing buses will take the ladies on a civic and cultural tour of Detroit. They will see Detroit's new Civic Center and tour the Historical Museum.

Highlights of Tuesday, October 17, will be a luncheon at the Roostertail, popular dining spot overlooking the Detroit River, and a talk on Japanese art by Mrs. Clarence McBryde.

Wednesday, October 18, will find the ladies touring Greenfield Museum and Village; luncheon will be served at Lovett Hall, and surprise gifts presented.

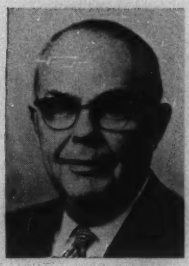
Off to Belle Isle and Windsor on Thursday, October 19, on a bus tour with time allowed for shopping in Canada. Naturalized citizens must have their citizenship papers.

Coffee will be served each morning in the Ladies' Hospitality Center in the Ivory Room of the Statler. This room may be used during the week for cards, tele-viewing and lounging.

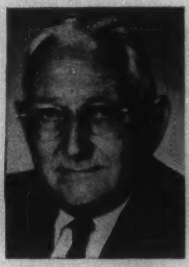
Registration Instructions Given

Registration may be made on Sunday, October 15, and tickets for the activities may be purchased at that time. Ladies are advised to obtain their luncheon tickets early, for reservations will close when the available tickets have been sold. Men are welcome to the activities which interest them.

The members of the Fall General Meeting Committee are: W. H. Frank, general chairman; L. W. Clark, vice-chairman; R. E. Bradstrum, secretary; H. M. Hess, treasurer; H. R. Armstrong, Hotels; O. E. Bowlus, Registration; A. P. Fugill, Finance; J. C. Leffel, Inspection Trips; B. H. Schneider, Hospitality; E. R. Narum, Entertainment; S. I. Whittlesey, Publicity; F. Von Voigtlander, General Sessions, and Mrs. R. E. Bradstrum, Ladies' Activities.



G. F. Corcoran



G. B. Griscom

Recognition Awards Committee Selects Recipients for Five AIEE Awards

THE AIEE Recognition Awards Committee has recommended that five awards be presented at the Fall General Meeting of AIEE on October 16 in Detroit, Mich. The awards and their recipients are as follows:

Medal in Electrical Engineering Education—George F. Corcoran (M '35, F '50), professor and chairman of electrical engineering, University of Maryland, College Park, Md.

William M. Habirshaw Award—Samuel B. Griscom (M '40, F '48), advisory engineer, Electrical Utility Engineering, Westinghouse Electric Corporation, East Pittsburgh, Pa.

Morris E. Leeds Award—Theodore A. Rich, consulting engineer, General Engineering Laboratories, General Electric Company, Schenectady, N. Y.

Mervin J. Kelly Award—Harry Nyquist (M '24, F '51), retired from Bell Telephone Laboratories.

David Sarnoff Award—Charles H. Townes, professor of physics, Columbia University, New York, N. Y.

Education Medalist Named

Prof. Corcoran was cited "for his contributions to electrical engineering education both in classroom teaching and in the creating of a series of undergraduate text books which have had far reaching influence on the education of electrical engineers."

Born September 26, 1900, at Redfield, S. Dak., he received the bachelor's degree in electrical engineering from South Dakota State College in 1923 and the master's degree from the University of Minnesota in 1926. At Minnesota, he was a teaching fellow and instructor. During 1927-31, he was an instructor and assistant professor of electrical engineering at Kansas State College, and in 1931-41 he served as associate professor and professor at the State University of Iowa. Since 1941, he has been professor and chairman of electrical engineering at the University of Maryland.

In 1935, he published "Introduction to Electric Transients" with E. B. Kurtz, and in 1938, "Alternating Current Circuits" with R. M. Kerchner. The latter textbook is now in its fourth edition. "Basic Electrical Engineering" was published in 1949, "Electronics" with H. W. Price in 1954, and "Introductory Electrical Engineering" with H. R. Reed in 1957. The third edition of "Alternating Current Circuits" has been translated into Spanish, and "Electronics" into Portuguese. The fourth edition of "Alternating Current Circuits" and "Basic Electrical Engineering" are being translated into Spanish.

THIS stainless-steel clad 250,000-gallon water tower symbolizes the ultimate at the ultra-modern General Motors Technical Center, site of another inspection trip scheduled for the Fall General Meeting.

Ezra Stoller

Habirshaw Award Winner Chosen

Mr. Griscom was cited "for outstanding contributions to the development and application of improved lightning and short-circuit protection of electric power systems, and high voltages for commercial and residential area distribution."

Born May 26, 1900, at Salem, N. J., he graduated from Cornell University in 1922 with the degree of electrical engineer. He joined the Westinghouse Electric and Manufacturing Company as a student engineer. In 1924, he was transferred to the general engineering department, and the next several years were spent assisting

T. A. Rich

Harry Nyquist

C. H. Townes

in the development of the theories of symmetrical components and the stability of power transmission systems. He invented the mechanical analogy to power system stability. In 1927, he was an exchange engineer with the Southern California Edison Company, principally in connection with their relatively new 230-kv transmission system.

Mr. Griscom became sponsor engineer in 1930 for the Westinghouse activities with the electric utilities in the east central states. Ten years later, this activity was transferred to the Northeastern Region, including the Westinghouse Electric International Company.

He was one of a group of engineers designated by Westinghouse to assist in the Manhattan Project, and was assigned toward securing the highest possible reliability from the generating and distribution equipment for the original Oak Ridge installation. He participated in the engineering of the Tidd High-Voltage Test Project, and is presently one of the project engineers on the 750,000-volt Apple Grove test facility.

In 1947, Mr. Griscom was made advisory engineer to the electric utility engineering department of Westinghouse Electric. In 1958, his activities became centered on development of high-voltage transmission techniques. He originated the prestrike theory of the lightning stroke. Among his inventions are high-speed reclosing of circuit breakers for prevention of transmission line outages, the distribution transformer scheme of grounding of unit-connected generators, several types of lightning surge recorders, and an aperiodic radio noise meter.

Leeds Award Winner Selected

Mr. Rich was cited "for outstandingly creative contributions to the field of Measurement thru exceptional awareness of new measurement needs and timely invention to accomplish the measurement."

He was born June 18, 1905, in Lynn, Mass., and was employed by the General Electric Company in 1923 at the Standardizing Laboratory in West Lynn, Mass. He received the General Electric Coffin Award for his method of soldering aluminum in instruments. Mr. Rich developed a resonant circuit frequency meter which is still in production and in wide use for which a second Coffin Award was given.

He entered Harvard University in 1927 and meanwhile worked summers in the General Electric Standardizing Laboratory. Another engineering award was given by General Electric for an aircraft tachometer developed by him and adopted by several airlines.

In 1929, Mr. Rich received the student paper prize at the AIEE North Eastern District Annual Student Convention for the paper, "The Development of a New Type of Indicator for Electrical Measuring Instruments."

After graduation in 1930, he went to General Electric in Schenectady, N. Y., and for 2 years was assigned to carrier current work and courses. Since then, he has been employed in the General Engineering Laboratory. He has done work on a variety of devices which use bimetal. He developed a welding monitor described in the paper, "Ampere-Squared Second Recorder," given an initial paper prize by the North Eastern District, and which appeared in AIEE *Transactions* of August 1941, pp. 839-42.

Mr. Rich developed fluxmeters for degaussing and harbor entrance submarine detectors for which a third Coffin Award was given. He worked on several electrostatic devices for radiation detection, flow meters, and regulators for production of fissionable material. He started in the aerosol field after the war and worked on the development of instruments as well as on building up an engineering technology in this field.

To Receive Kelly Award

Dr. Nyquist was cited "for his fundamental role in the evolution of modern communication and control theories."

He was born February 7, 1889, in Nilsby, Sweden. In 1914 and 1915, respectively, he received the B.S. degree in electrical engineering and the M.S. degree from the University of North Dakota. He was awarded the Ph.D. degree from Yale University in 1917.

During 1917-34, Dr. Nyquist worked in the department of development and research of the American Telephone and Telegraph Company where he was concerned with studies on telegraph, picture, and voice transmission. He continued this work at Bell Telephone Laboratories from 1934 until his retirement in 1954.

His contributions to the radio art include the first quantitative explanation of thermal, noise, signal transmission studies which laid the foundation for modern information theory and data transmission, the invention of the vestigial sideband transmission system now widely used in television broadcasting, and the Nyquist diagram for determining the stability of feedback systems.

Dr. Nyquist is presently an engineering consultant associated with the Lockheed Electronics Company and working part-time at Bell Telephone Laboratories on military communication problems.

To Receive Sarnoff Award

Dr. Townes was cited by the AIEE Committee "for research in resonance physics leading to major advances in communication technology."

Born July 28, 1915, in Greenville, S. C., he was educated at Furman University from which he received the B.A. and B.S. degrees in 1935 and the D.Litt. degree in 1960, the M.A. degree from Duke University in 1937, and the Ph.D. degree in 1939 from the California Institute of Technology.

In 1937, he became an assistant in physics at the California Institute of Technology. Two years later, he was employed by Bell Telephone Laboratories as a member of the technical staff. In 1948, he became associate professor of physics at Columbia University, and 2 years later, professor of physics, a position from which he is presently on leave of absence.

During 1950-52, he was executive director of the Columbia Radiation Laboratory. The next 3 years he was chairman of the Department of Physics, Columbia University. Since 1958, he has been a member of the Scientific Advisory Board, U. S. Air Force, and since 1959, he has been a consultant in the President's Scientific Advisory Committee.

Dr. Townes was an Adams Fellow at Columbia University in 1950, a national lecturer for Sigma Xi in 1951, a summer lecturer at the University of Michigan in 1952, a lecturer at the Enrico Fermi International School of Physics in 1955 and 1960, Guggenheim Fellow in 1955-56, a Fulbright lecturer at the University of Paris in 1955-56 and at the University of Tokyo in 1956.

Membership in the American Institute of Electrical Engineers, including a subscription to this publication, is open to most electrical engineers. Complete information as to the membership grade, qualifications, and fees may be obtained from Mr. N. S. Hibshman, Secretary, 33 West 39th Street, New York 18, N.Y.

New Group Insurance Program for Members Approved

AFTER a thorough study had been made by the Finance Committee and the Executive Committee, a Group Insurance Program was approved at the June meeting of the Board of Directors in Ithaca for the members of the Institute and their dependents. Participation in the program will be entirely voluntary on the part of the membership. There will be no personal solicitation at any time. The details of the program will be made known to the membership through periodic mailings.

The program will be administered by Smith, Sternau and Son Corporation of Washington, D.C., who have satisfactorily administered similar programs for the American Society for Civil Engineers, the American Society of Mechanical Engineers, and other engineering societies.

The program contains four different plans:

1. Loss of time plan
2. Major hospital-nurse-surgical expense plan
3. High-limit accidental death and dismemberment plan
4. Plan offering life insurance coverage

The action of the Board will allow the Administrator to present the first two plans immediately, and the first mailing will be made some time during September. The other two plans will follow in due course.

The program offers many advantages as compared with similar insurance available on an individual basis.

Insurance Plans Described

The four plans are as follows:

1. *Loss of Time Plan*, with benefits for disability due to either accident or sickness.

There will be a choice of benefits available of $200, $400, and $600 a month for lifetime accident and 2 years' sickness, with an extended plan, at a higher premium, for lifetime accident and 5 years' sickness. The cost and choice of benefits will depend upon the member's age at entry and premium increases at 10-year intervals beginning at age 40. Both options will also provide $5,000 accidental death or dismemberment benefits.

This coverage is renewable to age 75, though members over 70 are limited to $200 per month indemnity.

2. *Major Hospital-Nurse-Surgical Expense Plan*, with benefits for hospital room and board, miscellaneous expenses, nursing expenses while in the hospital and at home after hospital confinement, surgery, and limited doctors' calls in the hospital.

This plan will be offered with either $100 deductible, or $500 deductible. The cost will depend on a member's age at entry with premium increases at 10-year intervals beginning at age 40.

Surgical benefits are paid according to the severity of the operation, as listed in the contract, and they are paid in addition to room and board, nurses, and miscellaneous expenses. The Surgical Schedule is not subject to the deductible amount.

Surgical benefits will be increased 50% if a pathologically diagnosed cancer condition is directly involved.

Out-patient expenses for accidents are paid up to $50 for expenses incurred for treatment or service renderd by a doctor or a hospital as the result of an accident, if such treatment or service is received within 24 hours of the time of the accident and is not otherwise covered under the policy. The deductible amount also does not apply to this benefit.

This plan will be available not only to cover members, but may also include the member's spouse and children, if desired.

It is renewable without reference to age, though members over 70 are limited to the option with a deductible amount of $500.

3. *High Limit Accidental Death and Dismemberment Plan* will make available to the membership this type of protection with broader benefits and at lower costs than those under individual contracts.

The member will have the choice of protection for either:

a) Provision for 24-hour coverage for Accidental Death and Dismemberment and Total and Permanent Disability resulting from accident. Deaths caused by private automobiles are included.

The coverage will be available to members under age 70 in principal sums from $25,000 to $200,000 at an annual premium of 90¢ per $1,000, in units of $25,000. For members aged 70 and over, coverage will be offered in principal sums from $25,000 to $100,000 at an annual premium of $1.35 per $1,000.

The $25,000 coverage will be available to the spouse of a member at the same rates.

b) Travel Accident for Business or Pleasure which will cover Accidental Death and Dismemberment only in a licensed carrier. Deaths caused by private automobile will not be included. This alternate coverage will be available in the same amounts as the broader coverage described above, at a cost of 40¢ per $1,000 under age 70, and at 60¢ per $1,000 thereafter. It would provide death and dismemberment benefits for travel accidents in licensed carriers (planes, trains, busses, etc.), but would not provide benefits for permanent and total disability.

4. *Life Insurance Plan*. This Plan will also contain two options: Plan A for $10,000, and Plan B for $20,000, as well as coverage for dependents in amounts equal to 50% of the member's insurance under Plan A for the spouse, with $500 for each child between the ages of 15 days and 6 months, and $1,000 from 6 months to 19 years.

The cost is on a step-rate basis, increasing every 5 years to the age of 60, at which time the amount of insurance will diminish and the premium remain constant.

Additional Information Given

The Group Insurance Program for the Loss of Time Plan and The Major Hospital-Nurse-Surgical Expense Plan will start when the first 100 acceptable applications are received. The plans will be underwritten by the American Casualty Company of Reading, Pa.

If an application is not considered acceptable by the insurance company, a certificate will be issued anyway, if at least 40% of the total members of a Section, or of the entire AIEE membership, enroll during the Charter Enrollment Period of 3 months.

The insurance company, however, reserves the right to limit the impaired risks to $200 monthly indemnity under the Loss of Time Plan and to Plan B ($500 Deductible) under the Major Hospital-Nurse-Surgical Expense Plan.

For qualification purposes only, a Section having less than 100 members will be combined with other such Sections.

While the approved program will be available to all classes of membership, student members will be limited to participate only in the Major Hospital-Nurse-Surgical Expense Plan, as the Loss of Time Plan is predicated upon gainful employment.

Additional information on this insurance program follows:

1. Your Group Insurance Program provides world-wide coverage.

2. Full benefits are paid under all plans in the program regardless of any other insurance or other source of income.

3. An allowance of 31 days of grace is made for payment of renewal premium. In case of an oversight or for any reason a subscriber cannot make payment, coverage automatically continues in force for these 31 days.

4. Once it is validly in force, the insurance of an individual member cannot be cancelled by the company as long as he remains a member of the Institute and the program remains in force. The Loss of Time Plan, however, must be dropped when a member retires or reaches 75, and the Loss of Time and Major Hospital-Nurse-Surgical Expense Plans require transfer to options with more limited amounts of coverage after age 70.

5. Premium payments for the Loss of Time Plan are waived after a period of 6 months' continuous total disability for which benefits are payable, and benefits continue for the length of the disability up to the maximum period of payment provided under the terms of the policy.

6. For certain fractures and dislocations, subscribers are guaranteed a minimum number of weeks of indemnity under the Loss of Time Plan, regardless of how long subscribers are actually disabled.

PRESENTATION of the Lamme Medal to Dr. J. G. Trump (*third from left*) was made by AIEE President C. H. Linder (*second from left*). H. R. Stewart (*left*) gave the biographical talk about the recipient, and J. L. Cantwell spoke on the history of the medal.

1,400 Engineers and Guests Attend Summer General Meeting in Ithaca, N.Y.

THE AIEE Summer General Meeting was held June 18-23 on the Cornell University campus, Ithaca, N. Y. Willard Straight Hall was the headquarters for the gathering, which was attended by approximately 1,400 engineers and guests. There were 150 technical and conference papers presented at the 36 sessions.

Among the social events were a talk by Dr. A. A. Allen, ornithologist, four evenings of informal cabaret in the Statler Ballroom, and a chicken barbeque which had to be held indoors because of inclement weather instead of on Schoellkopf Field. Members and guests also enjoyed golf, tennis, and swimming.

Inspection trips were made to the High Voltage Cable research and test project, the Cornell Ornithology Laboratory, National Homes, the Cornell Computing Center, the Ithaca Gun Company, Great Western Wineries, the General Electric Advanced Electronics Center, and the Endicott plant of International Business Machines.

Cornell Compared to AIEE

Prof. S. Linke opened the meeting and welcomed the guests. He compared Cornell University's growth with that of AIEE and spoke about Cornell's various schools with their $89 million annual operating expenses.

Prof. Linke next introduced AIEE Vice-President C. E. Gaylord of District 1, who welcomed the members.

AIEE President S. H. Linder then told how the Board of Directors had appointed a committee to promote a program of Institute action, a task force to study the committee chairmen and personnel.

AIEE Treasurer W. R. Clark stated that the Institute's finances were "in a sound state of health," after he presented some of the cost figures for moving into the new headquarters at the United Engineering Center.

President Linder thanked L. M. Goldsmith, W. E. Scholz, and H. H. Sheppard for their efforts in raising money for the new headquarters. He reported that the member vote had been in favor of the amendment to the AIEE Constitution.

President Linder presented President-Elect W. H. Chase, vice-president of District 14, with the President's Badge.

Dr. T. T. Goldsmith, Jr., gave a brief biography of Dr. A. B. Du Mont (F '43), who was presented with a certificate of honorary membership. (For Dr. Du Mont's speech of acceptance see p. 577.)

Student Awards Presented

Certificate and awards were presented to the winners of the Students Prize Papers Contest in the various districts by President Linder. The prize paper winners and the titles of their papers are:

W. A. Anderson, T. C. Stoiber, University of Buffalo, "Infrared Position Servo"; R. G. Chapman, Jr., Princeton University, "The Modified Coherer as a Bistable Element"; Allen Chertok, New York University, "A Survey of College Radio Carrier Current Broadcasting Facilities"; W. E. Montgomery, Duke University, "A Pulse-Sampled Video Recording System"; J. B. Murphy, Bradley University, "Solution of Non-Linear Electrical Machine Transients"; L. D. Feisel, Iowa State University, "A Remote Control System Using Pulse Position Modulation"; D. W. Peterson, Washington University (St. Louis), "A Low Frequency Mechanical Generator"; R. F. Overmyer, California

C. Hadley Smith Photos

HONORARY membership in AIEE was given to Dr. A. B. Du Mont (*left photo, at right*), who received a certificate of honorary membership from AIEE President C. H. Linder. Dr. Du Mont is chairman of the board of the Allen B. Du Mont Laboratories, Clifton, N. J. Pinning the President's Badge on AIEE President-Elect W. H. Chase (*right photo, at left*) is the incumbent President Linder. Mr. Chase, who begins his term of office on August 1, is vice-president of the Ohio Bell Telephone Company, Cleveland, Ohio.

State Polytechnic College, "Analysis and Synthesis of a Sampled-Data Model of the Human Operator"; D. R. Harrison, University of Utah, "The Initial Acceleration and Detection of Charged Micron-size Particles"; T. N. Teick, University of Dayton, "Measurement and Generation of Noise"; C. J. Neuse, University of Connecticut, "The Tunnel Diode—Its Operation and Characteristics"; W. K. Mitchell, F. L. Treece, University of Alabama, "A Receiver Activated Transmitter Block for Aircraft Radios"; F. D. Moore, A & M College of Texas, "Impedance Characteristics of Logarithmically Periodic Antennas."

The Lamme Medal was awarded by President Linder to Dr. J. G. Trump. J. L. Cantwell gave a history of the medal and H. R. Stewart gave the biographical talk about the recipient. See p. 596 for the complete speeches.

Board of Directors Takes Action on Matters of Significance to Membership

THE 1960-61 Board of Directors and its Executive Committee, during the 1961 Annual Meeting week at Cornell University, concluded its administration with several actions of considerable direct significance to the membership.

Group Insurance

AIEE members will soon have the opportunity to exercise their collective purchasing power and take advantage of the favorable insurance experience with professional people in a group insurance program. The Board of Directors approved two plans to be offered to the membership this Fall. The first is a Major Hospital-Nurse-Surgical Expense Plan with several options especially attractive to older members approaching retirement. A second plan covers Income Protection in case of accident or illness. Full details of the program will be mailed to all members.

Leadership Development

Approval in principle and a directive to proceed immediately for early implementation was given to the Planning and Co-ordination Committee on a plan for the active development of officer material in all units of the Institute. Based on experience in several Districts, the Board moved to set up development committees for the systematic stimulation, identification, and evaluation of candidates for responsible positions of leadership throughout the Institute. No change in the essential constitutional methods of nomination, election, and appointment is contemplated. The plan is directed at insuring an ample supply of qualified candidates for both elective and appointive offices.

Model Law Not Approved

The Model Law for the registration of engineers, adopted by the National Council of State Boards of Engineering Examiners and offered to the Societies for endorsement, failed to win approval by the AIEE Board in a vote at the June meeting. The position taken by the AIEE Professional Development and Recognition (PDR) Department and supported by the Board is that there remain in the proposed model legislation too many phrases subject to uncertain interpretation and possibilities for application beyond the basic agreed purpose. At the time of the Board meeting this view seemed to be shared by four of the five Founder Societies.

Cognate Society Privileges

Members of the British Institution of Electrical Engineers in Canada and Mexico may now join AIEE without payment of entrance fee and without length of residence restrictions. Associate Members of AIEE who hold Senior Member status in the Institute of Radio Engineers are now, as a result of a bylaw amendment effective August 1, 1961, eligible to transfer to Member grade in AIEE without securing references or submitting detailed records. The transfer fee, however, remains in force.

Fellow Requirements

The Board approved a modification of the "Code of Practice" of the Board of Examiners permitting waiver, upon prior application, of the requirement of five Fellow references for the transfer to Fellow grade. Seventeen Fellows were elected at this Board meeting. Their biographies will appear in *Electrical Engineering* at a later date.

Schools Approved

Arlington State College, Arlington, Tex., and Tri-State College of Angola, Ind., were approved for the acceptance of student members and the establishment of Branches. The subcommittees of the PDR Department on Domestic and Foreign Schools continue their study of criteria for eligibility for membership in the Institute.

Finances

As reported in the digest of the 1960-61 Annual Report entitled "AIEE Today" in this issue of *Electrical Engineering*, p. 605, the fiscal year ended with a clear surplus of operating funds after an accelerated write-off of furniture. Other financial news was made by the Board in making the extended Section meeting bonuses and entrance and transfer fee rebates a part of the bylaws rather than a matter of annual appropriation.

Elections and Appointments

B. R. Teare, Jr., dean of engineering at Carnegie Institute of Technology, was elected to the Board as a Director-at-Large to fill the vacancy created by the death of R. B. Gear of Chicago, Ill. A full list of officers and committee chairmen for 1961-62 will be published in the September issue of *Electrical Engineering*.

STUDENT prize paper winners at the Summer General Meeting of AIEE at Cornell University, accompanied by A. S. Brower *(standing, at left)*, General Electric Company, Schenectady, N.Y., host to the group for the Student Branches. The winners were: *(standing with Mr. Brower, left to right)* J. B. Murphy, Peoria, Ill.; R. G. Chapman, Jr., Evansville, Md.; L. D. Feisel, Tama, Iowa; R. F. Overmyer, San Luis Obispo, Calif.; F. D. Moore, Cameron, Texas; D. W. Peterson, St. Louis, Mo.; *(seated, left to right)* Allan Chertok, New York, N.Y.; D. R. Harrison, Spartanburg, S.C.; F. L. Treece, Boaz, Ala., and W. A. Anderson, Sinclairville, N.Y.

GAVELS and certificates for the Annual Section Growth Awards were presented at the Section Delegates Meeting to the winning Sections. Shown are: (*left to right*) E. J. Terhaar, Sacramento Section, second place in smaller than average Section; H. O. Bourque, Baton Rouge Section, first place in smaller than average Section; W. E. Scholz, chairman, Sections Committee; Lester Ulm, Florida West Coast, first place in larger than average Section; Howard Brem, vice-chairman, Section Committee, and M. T. Hatley, North Carolina Section, second place in larger than average Section.

Section Delegates Meet June 20 during AIEE Summer General Meeting

THE AIEE Section Delegates Conference was held on June 20 at Cornell University during the Summer General Meeting.

Chairman W. E. Scholz called the conference to order at 9:10 a.m. He discussed the "Timetable" and introduced the AIEE Headquarters staff.

AIEE President C. H. Linder welcomed the delegates and spoke about the reasons for being of the engineering societies, the spread of technical knowledge to the younger engineers, and the importance of a definite professional status for engineers.

President-Elect Chase Introduced

AIEE President-elect W. H. Chase, who was next introduced, suggested that the Section delegates inform themselves in depth concerning AIEE. He stressed that a Section chairmanship was good training for future AIEE jobs and that the Sections should court students as AIEE members of the future.

D. T. Michael, chairman of the Membership Committee, reported an AIEE membership increase of about 1% during the past year. Sections will be informed of members who have not paid their Institute dues, so that the delinquents may be contacted. Sections were urged to place representatives on national technical committees.

G. R. Wilhelm, chairman of the Transfers Committee, mentioned the need of a new bylaw to the effect that the vice-presidents be in charge of transfers and that they appoint Transfers Committee personnel. A manual covering transfers has been completed and will be distributed to the Sections.

R. R. Krezdorn spoke of general difficulty encountered in obtaining the addresses of recently graduated student members. It was suggested that these men be written to by Section members in new localities and also that they be assisted in finding houses, churches, etc. Section members were urged to appear on student panels to advise the students on future jobs and to answer questions.

After an intermission, W. R. Clark, AIEE treasurer, gave the delegates a brief report on the Institute's finances: The income and expenses were high in 1960 and 1961, and the 1962 budget is even higher, yet a small surplus at the end of the period is expected. He also explained the expenses of the General Administration Department and those of the Sections Committee.

The Section Growth Awards were announced, as follows:

Smaller Than Average

1. Baton Rouge	39.5
2. Sacramento	36.3
3. Richland	34.2
4. Northeastern Michigan	33.6

Larger Than Average

1. Florida West Coast	51.6
2. North Carolina	14.4
3. Central Indiana	13.5
4. Montreal	12.0
5. Syracuse	9.5

Gavels were awarded to the Sections with the greatest growth, and certificates to the runners-up, in each classification. It was announced that in the future study groups will be included in the Section Growth Awards calculations. The figures were based on ±440 members as average.

It was announced that a petition had been presented and approved for the formation of the new North Piedmont Subsection of the North Carolina Section in District No. 4. The four North Carolina Counties of Alamance, Guilford, Randolph, and Rockingham have been

WINNERS of the Public Relations Committee Awards for the AIEE Sections which did the best over-all public relations job during the year were presented with transistor radios by E. C. Gaylord (*left*), vice-president, and C. F. Savage (*right*), national public relations chairman. The winning Sections were represented by R. L. Hancock (*middle left*) of the South Texas Section and J. C. Gray (*middle right*) of the Lehigh Valley Section. The presentation took place at the Summer General Meeting at Cornell University.

assigned to this new Subsection; its organization date will be August 1, 1961. When this change becomes effective, there will be 78 Subsections and 119 Sections in the Institute.

AIEE Has Reached Its Quota

W. J. Barrett, former AIEE president, announced that the AIEE had reached its quota of $900,000 for the new United Engineering Center (UEC) and asked that the delegates extend his thanks to the Sections.

H. H. Sheppard, of the Fund Raising Committee, told how AIEE had reached its quota goal and congratulated the Sections on their money-raising efforts. As the result of a reminder for the UEC fund, mailed in May with bills for the Institute's dues, $17,000 was raised. The following Sections at this time presented these amounts for UEC continuation fund:

Cleveland, $750
Philadelphia, $3,000 (second donation)
Milwaukee, $500
Vancouver, $300

The conference adjourned for the luncheon period.

Chairman Scholz called the conference to order at 2:00 p.m. and introduced C. F. Savage, Jr., chairman of the Public Relations Committee. He explained the questionnaire which the Sections' public-relations chairmen had been asked to answer; 32 of these had been returned to Headquarters. Prizes of portable radio receivers were awarded to the first and second Sections who had attained the most newspaper and radio publicity; these were, first prize, Lehigh Valley Section, and second prize, South Texas Section.

Mr. Savage introduced J. J. O'Connor, next year's chairman of the Public Relations Committee. Mr. O'Connor said that it was everybody's job to publicize AIEE and made suggestions as to how to do it. He distributed copies of the "AIEE Compendium," which lists the publications of value to Section workers in public relations.

P. K. McElroy, chairman of the Committee on Institute Technical Groups (ITG) was introduced; he told of how the idea was brought into being: The ITG, he said, is a connecting bridge between the grass-roots members and the technical committees. Mr. Scholz assured the delegates that ITG will not interfere with the various technical discussion groups of the Sections.

The delegate from the Detroit Section urged the conference as a whole to attend the Fall General Meeting next October.

Chairman Scholz expressed the opinion that various Sections should not become involved in political affiliations and urged that no Section should try to influence legislation.

H. C. Brem, who will be chairman of the Sections Committee next year, assumed the chair and presented "Hard Work" awards (inscribed mugs) to W. E. Scholz and G. B. Schleicher, the retiring chairman and secretary, respectively.

The conference adjourned at 5:15 p.m.

Forum Hears about Rapid Changes in Industry and Ways To Meet Challenge

THE 26th Forum of Technical Committee Chairman heard about a number of important matters which had to do with standards and standardization, research, new technical activities, the processing and distribution of papers, and the Electrical Engineering Exposition. The Forum took place June 22 and the meeting was called to order by Vice-Chairman D. E. Trucksess of the Technical Operations Department.

Standards and Standardization

In respect to the subject of standards and standardization, AIEE President C. H. Linder first drew attention to the rapidly changing situation in respect to the economy, and that the impact of imports was being felt, and that industry must compete in the world markets as well as in the United States market. Because some industries have moved their manufacturing to Europe and Japan, and a great many are buying components from abroad, a soul-searching job was urged to keep the manufacturing here and to employ people in the United States. The automotive industry, he said, has solved its problem by designing compact cars to meet the needs of the American market.

Heretofore, Mr. Linder said, our designs were optimized around labor because there was an abundance of material in the United States. To compete in the world markets as well as the United States markets, he said it will be necessary to optimize designs around both labor and materials as well as to rapidly standardize. He summarized the following facts: In this country, the AIEE and other societies are active in standardization, as well as the trade associations such as EEI (Edison Electric Institute), NEMA (National Electrical Manufacturers Association), and so forth, with ASA (American Standards Association) as the "umbrella organization." This represents a tremendous hierarchy. As AIEE was an individual membership organization with people acting without instruction from the companies, the view was expressed that the Institute could contribute by expediting procedures. The Institute, Mr. Linder believes, should take a leadership position in the matter of standardization.

Research and Electrical Engineering

The ultrarapid progress in the field of research and electrical engineering since the war was outlined by B. G. Ballard, chairman of the Research Committee. He feels that the new knowledge accumulated in the past 10 years is the equivalent of all the technical knowledge accumulated to 1951. Mr. Ballard noted that seven out of ten who have made new discoveries are living today to see their work put to fruitful applications.

Engineering, Mr. Ballard believes, should keep abreast of scientific develop-

C. Hadley Smith

SIX Sections of AIEE presented contributions to the new United Engineering Center (UEC) fund-raising campaign at the recent Section Delegates Meeting at Cornell University. Shown presenting checks to W. E. Scholz, secretary, UEC Member Gifts Campaign Committee, and Howard Sheppard, vice-chairman (*at right*) are: (*left to right*) R. E. Begley, Hudson Valley Section; D. G. Donaldson, Ottawa Section; W. O. Mascaro, Philadelphia Section; J. C. Ponstigl, Cleveland Section; H. C. Brem, Milwaukee Section, and E. A. Harvey, Vancouver Section.

ments, and that the universities and the AIEE have a great responsibility. The speaker deplored the fact that research today is still regarded as an extracurricular activity in many of the colleges. He concluded by explaining that one should be prepared to explore the most unorthodox proposals and suggested the AIEE must publish the best of the research work whenever possible. Because of the great need for careful observation of the latest scientific progress, it is imperative, he said, that the nation occupy a leading position in the forefront of scientific advancement.

Challenge of New Technical Activities

It was explained by R. A. Ramey, chairman of the New Technical Activities Committee, that if his audience noted new words creeping into his vocabulary, it probably meant that he was engaged in new technical activities. Military needs, he said, have started money flowing freely into new activities for a period of years, which are beginning to bear fruit in the fields of energy conversion, solid-state devices, and the magnetic spectrum. He regards the AIEE as a flexible organization, providing for the advancement of the theory and practice of the allied arts and sciences. The speaker explained that there was little hesitancy on the part of the 52 technical committees and 217 subcommittees to embark on new activities, that AIEE has not lost the opportunity to expand and serve the membership, and that suggestion was all that was necessary to create action.

Processing Quality, Paper Distribution

A preliminary report on the paper policy was outlined by A. P. Hayward, chairman of an Ad Hoc Committee on Processing Quality and Distribution of Papers. He reported on the replies received to a questionnaire sent to all technical committee chairmen and all division chairmen, which indicated that there should be a change in the reviewing, classifying, and printing procedures with no distinction between technical papers and preprinted conference papers until after the meeting. The majority, he said, also favored that all papers except conference papers should be preprinted and made available to the membership and that the Institute should retain title rights to all papers.

Two distinct approaches to the proper procedure for the presentation of papers were recognized. Some members feel that there could be an improvement in the quality of papers and that the large number of conference papers given without preprints make it difficult to prepare discussions. Members in the electronics and science groups were less interested in the availability of preprints prior to the meetings but feel that the material presented should be retained in a form easily made available to all members of the Institute.

The Ad Hoc Committee intends to study the matter further and make a more complete survey by a sample of authors, exchairmen of committees, and others particularly interested in Institute affairs. A review of procedures by other societies will be studied with the possiblilty that a review of the successes and failures would be of assistance in formulating a suggested policy.

Automatic Distribution of Papers

A carefully worked out proposal for the automatic distribution of all technical papers was presented by C. A. R. Kagan, vice-chairman of the Computing Devices Committee. The first step in the procedure would be for the technical committee chairmen to classify all papers according to the interests of the technical committees and classification identifiers would be printed on every copy of a paper. These identifiers would be used as the basis for direct mail distribution to the members of the Institute on the basis of an annual expression of their interests. Subscriptions would be on an annual basis at the end of the fiscal year or in advance on a predicted basis. With the proposed procedure, the need for the bimonthly publications would no longer exist since individuals could be guaranteed to receive all papers pertaining to their interests. The rating of papers in respect to publication in the *Transactions* or as conference papers would not be announced in advance of presentation.

In advance of the meeting, session chairmen would be sent copies of the papers to encourage preparation of discussions. Session chairmen would also be provided with rating forms, providing for a rating in respect to novelty, interest, quality of presentation, and notable discussions from the floor. The session chairmen would also have the responsibility of procuring directly from the speaker a copy or copies of the paper immediately after the session. The ratings and papers would be transmitted to the technical committee chairmen.

Written discussions and those submitted at the time of the meeting would be sent to the Technical Operations Department to receive the same file number and classificitation identifiers as the original paper. After review of discussions, those accepted would automatically be distributed to the subscribers of the indicated interest categories. Authors' rebuttals or closures would be handled in the same manner. Periodical indexes and cross reference lists would be prepared by interest categories from time to time to make it possible for those who are not subscribers or those who wish to have additional copies of the papers to order individual papers or entire groups of subject matter.

Exposition Facts and Opportunities

Facts about the Exposition next winter and the opportunities afforded were outlined by J. J. Anderson, secretary, Winter General Meeting Committee. Seventy per cent of those attending the Winter General Meeting answered a questionnaire requesting that there should be an Electrical Engineering Exposition and some 43% of those responding had not attended an exposition in recent years. Some technical sessions from each division, about 30 sessions, would be held at the Coliseum. As the electrical industry buys and sells horizontally with raw materials going into the original equipment, members were urged to exert their influence and request their companies to sign up for the exposition. Copies of a brochure explaining the market, the official floor plan, and so forth, can be obtained from the Reber-Friel Company, 117 S. 17th St. Philadelphia 3, Pa.

Some 46 firms already have signed up for space at the Electrical Engineering Exposition, ranging from manufacturers of components to manufacturers of subassemblies. The entire first and second floor have been reserved for exhibit space and the fourth floor will be devoted to technical sessions; hence co-operation and participation are urgently requested.

In discussion of these matters, several points were brought to attention. In connection with the Electrical Engineering Exposition, Mr. Kagan suggested that the manufacturers should be requested to show historical exhibits.

In connection with the plan for automatic distribution of all papers, the question was raised as to whether such a plan would not be in conflict with Institute Technical Groups (ITGs); but Mr. Kagan thought that the plan rather than being in conflict would strengthen the ITGs. J. F. Calvert suggested that a pilot model of the automatic distribution plan might first be tried. Another speaker pointed out that some years ago, the Power Division curtailed its programs to permit the Electronics Division to get a good program under way and the trial period has been sufficient; hence a careful look should be taken at the proposed review procedure. It was explained by Mr. Kagan that the review procedure was just as thorough if not more so because the ratings of the chairmen of the session and the discussion from the floor would be taken into consideration.

Still another speaker, W. A. Lewis, raised questions concerning the cost of the plan and he pointed out that if the bimonthly publications were to be abandoned, all of the first costs for composition, engraving, and higher printing production costs would have to be transferred to the *Transactions*.

Engineering Library To Move 180,000 Volumes to New Building

The Engineering Societies Library will move its 180,000 volumes—about 6 miles of books—to the United Engineering Center at 345 E. 47th St., New York 17, N.Y., shortly after completion of the building, which is scheduled for some time in August. It is expected that moving the Library will take about 3 weeks.

During this time the Library expects to continue to answer, but probably with some unavoidable delays, all requests received by mail for general engineering information, and for all services, including literature searches, translations, and microfilm and photocopies from publications in the Library. The Reading Room will be closed, and telephone service will be curtailed for approximately the period of the move. It is hoped by its personnel that the Library will again be giving full service by Labor Day or soon thereafter.

LARGEST electric generating plant west of the Mississippi, the Pittsburgh Power Plant is the property of the Pacific Gas and Electric Company. In the foreground is piping for the intermediate gas pressure regulator which furnishes fuel for the Power Plant. This plant will be toured during the National Power Conference.

1961 National Power Conference Will Take Place in San Francisco

THE 1961 National Power Conference, sponsored by the Power Divisions of AIEE and the American Society of Mechanical Engineers (ASME) with the cooperation of the San Francisco Sections of AIEE and ASME, will be held September 24-27 at the St. Francis Hotel, San Francisco, Calif.

Registration Instructions

The Olympic Room at the St. Francis Hotel will provide a pre-registration meeting place for participants. It will be open Sunday, September 24, from 4:00 p.m. to 8:00 p.m. Registration will be open at this time at a cost of $8 for members only. On the following day, the registration fee, payable on arrival, will be $10. Nonmembers' registration fee will be $12, and student members', $2. Ladies will be admitted without charge.

Advance registration cards should be received no later than September 11 if confirmation of reservation is desired. Principal housing will be assured at the St. Francis, located opposite Union Square in the heart of downtown San Francisco. There is a large garage below Union Square with direct underground walkway access to the hotel. Excellent other hotel accommodations are available in the immediate neighborhood at similar rates. Daily rates are:

Single room	$11 to $23
Double-bed room	$14 to $22
Twin-bed room	$16 to $26
Suites (living room and twin-bed room)	$30 to $55

If a room at the rate requested is unavailable, one at the nearest available rate will be reserved.

Luncheons are arranged for Monday and Wednesday at a price of $4.50 each. Speakers will be W. H. Byrne, president of ASME, and W. H. Chase, president of AIEE.

Tuesday evening, September 26, the reception and banquet will be held in the Colonial Room at the St. Francis to mark the social high point of the conference. This will be the occasion of the address by Fred Seaton, former Secretary of the U.S. Department of the Interior.

Some 24 technical papers will be presented at the conference in the California and the Italian Rooms. These have been arranged by L. A. Kilgore of the AIEE Power Generation Committee together with F. G. Feeley, Jr., of the ASME Power Division and their San Francisco representative, V. F. Estcourt. Sessions are scheduled which cover:

1 Nuclear plants
2 Boilers
3 High-temperature steam
4 Operating economics
5 Automation
6 Plant performance testing
7 Turbine generators

Inspection Trips

Inspection trips have been planned as follows:

Wednesday, September 27. Pittsburg Power Plant, Pacific Gas and Electric Company. The Pittsburg Power Plant, located near the city of Pittsburg, Calif., contains many innovations in thermal plant construction. This will be a free all-day tour.

Thursday, September 28. Geysers Power Plant, Pacific Gas and Electric Company. This plant, nearly 100 miles north of San Francisco, Calif., in the geothermal region, is the only natural steam plant in this country. The tapping of the underground steam is of interest in itself, but engineers will find other interesting problems and solutions in the unique corrosiveness of the steam and the methods used to circumvent its effects. The capacity of the plant is due to be increased in the near future with the development of a greater supply of steam. This will be an all-day free visit which will follow the meeting.

Wednesday, September 27. San Francisco Bay Area Salt Water Conversion Research Center. This is an experimental plant, designed for research and operated by the University of California, for the purpose of determining the cost and practicality of making potable water from sea water. At present, studies are being made of multieffect distillation, vacuum flash distillation, solar distillation, vapor compression distillation, freezing, reversed osmosis, ion exchange, electrodialysis, and nuclear reactor studies as a source of heat. The cost of this trip will be $1.50.

In addition to the arranged inspection trips, other technical facilities in the area will be made available on an informal basis to those who are interested.

The Sunnyvale manufacturing plant of the Westinghouse Electric Company is about 35 miles south of San Francisco. This is a large, diversified facility, where much of the design and manufacturing is done by this company for the entire West Coast and the Pacific Basin.

The Vallecitos experimental atomic power plant of the General Electric Company is located about the same distance southeast of the city. Here, in co-operation with the Pacific Gas and Electric Company, is the first privately financed, atomic power plant, quietly generating a small base load, while the results of the research carried on have already resulted in the Dresden plant and a new, financially sound plant under construction at Eureka, Calif.

The Santa Clara, Pacific Power Division, plant of the Federal Pacific Electric Company is located at Santa Clara, about 40 miles south of San Francisco and near Santa Clara University, where 60-cycle electricity is taught. The high-voltage laboratory at this location is used in the development of oil circuit breakers, air switches, transformers, bushings, and other power equipment. It has two cascade banks, each capable of 1,050 kv to ground, and an impulse generator producing surge voltages of up to 2 million volts to ground..

Ladies Program Scheduled

Ladies' activities will be centered in the Hospitality Room (266), each day from 9:00 a.m. until noon. Coffee and rolls will be served. Hostesses will also be present on Monday and Tuesday from 2:30 to 4:30 p.m.

On Monday, September 25, there will be available from 9:30 a.m. to 12:30 p.m.

a Gray Line tour of San Francisco. This is the famed 49-mile drive. The price is $3.10, which includes federal tax. Following the tour, there will be a 1:00 p.m. luncheon and fashion show at the St. Francis. This will be a no-host luncheon.

On Tuesday, September 26, there will be a tour of Chinatown, organized by Chiangwah Lee, to start at 10:30 a.m. and end at 12:00 noon. The charge will be $1.00 per person, no-host lunch to be at Johnny Kan's in Chinatown.

Wednesday, visitors may see San Francisco and the rest of the Bay Area from a sightseeing boat. They may also take an all-day bus tour to the vineyard country and a visit to the Buena Vista Winery. Either tour will entail a transportation charge.

Available Transportation Given

Plane, train, or bus facilities have terminal connections at San Francisco. Reservations should be made well in advance, because direct connections from some parts of the East are chronically difficult to secure on short notice owing to a shortage of direct plane connections.

Airport, bus, and taxi service to the St. Francis is available at the airport, as are connections at train and bus terminals. The bus terminals are about 1 mile from Union Square, the Southern Pacific Railway Depot about 2 miles, and the airport central terminal 2 to 3 blocks.

Conference Committee

The General Committee of the conference includes the following: M. W. Wangsness, general chairman; M. A. Moler, co-chairman; R. L. Mellers, secretary; A. H. F. Barlow, treasurer; W. H. Nutting, registration; W. F. Poynter, publicity; J. N. Ylarraz, hotel and meeting facilities; H. V. Smith, plant trips and transportation; Jack Robinson, reception and information; W. J. Lindblad, technical events; Mrs. J. T. Cochran, ladies' program; Bob Decker, banquet and entertainment; V. F. Estcourt, L. A. Kilgore and F. G. Feeley, Jr., program; R. E. Grady, AIEE Section chairman, and E. G. Chilton, ASME Section chairman.

The mail address for the National Power Conference will be the St. Francis Hotel, San Francisco 19, Calif.

Availability of ASME Papers

Only numbered ASME papers in this program are available in separate copy form until July 1, 1962. Prices are 50 cents to members of ASME and $1 to nonmembers, plus postage and handling charges. Payment may also be made by free coupons which may be purchased from the society in lots of ten at $4 to members and $8 to nonmembers. Postage and handling charges can be saved by including a check or money order made payable to ASME with each order, and sending both to: ASME Order Dept., 29 W. 39th St., New York 18, N. Y. Papers must be ordered by the paper numbers listed in this program; otherwise the order will be returned.

Technical Program Given

The tentative technical program follows:

Monday, September 25

9:00 a.m. Session 1—Nuclear Plants

Spectral Shift Control Reactor. *James Coughlin*, Babcock & Wilcox Co.

Status of the High Temperature Gas-Cooled Reactor. *Titus LeClair*, General Dynamics Corp.

CP61-983. The ESADA Vallecitos Experimental Superheat Reactor. *John Barnard*, General Elec. Co.

Hallum Nuclear Power Facility, Prototype for Advanced Sodium Cooled Power Station. *R. C. Gerber, G. L. Larson*, Atomic International; *R. W. Dickinson*, General Elec. Co.

2:00 p.m. Session 2—Boilers

Low Head Boilers for Industry. *R. H. Wolin*, Combustion Engineering

Operating Experience from a New Concept of Industrial Boiler Design. *T. B. Hurst*, Babcock & Wilcox Co.; *Jack Campbell*, Richfield Oil Co.

Inspection of Eddystone Station and Conclusion Regarding 1150° F. Steam. *J. H. Harlow*, Phila. Elec. Co.

8:00 p.m. Session 3—High Temperature Steam

Metallurgical Evaluation of Superheater Tube Alloys after 12 and 18 Months Exposure to Steam at 1200°, 1350° and 1500° F. *C. L. Clark*, Timken Roller Bearing Co; *J. J. B. Rutherford*, Babcock & Wilcox Co.; *A. B. Wilder*, U. S. Steel Corp.; *M. A. Cordovi*, International Nickel Co. (ASME Paper No. 61—PWR-4)

Scale Formation on Austenitic and Ferritic Materials Exposed to High Temperature Steam. *F. Eberle, C. H. Anderson*, Babcock & Wilcox Co. (ASME Paper No. 61—PWR-3)

Evaluation of Weldments Joining Super-heater Tube Alloys After Exposure to Steam at Temperatures of 1110-1500° F. *W. E. Clautice*, U. S. Naval Engineering Experiment Station

The Effect of Corrosion by Steam at 1100-1500° F. Upon the Heat Transfer Through Superheater Tube Alloys. *H. L. Solberg, J. E. Brook, W. J. Rebello*, Purdue Univ. (ASME Paper No. 61—PWR-1)

8:00 p.m. Session 4—Operating Economics

Transmission of Electric Energy Versus Transportation of Fuel. *W. E. Hopkins*, Stone & Webster Engineering Corp.

Factors Affecting the Selection of Auxiliary Drives. *J. J. Heagerty*, General Elec. Co.

Significance of Outage Records in Estimating System Growth Requirements. *E. S. Loane*, General Public Utilities Corp.

CP61-986. Economic Scheduling of Generation by Valve Points. *A. P. Hayward*, Duquesne Light Co.

Tuesday, September 26

9:00 a.m. Session 5—Automation

Philosophy of Boiler Automation. *R. D. Hottenstine, R. W. Egglestone*, Combustion Engineering

An Approach to Automation of Power Plants Using the Concept of Parallel Programming. *H. H. Gorrie*, Bailey Motor Co.

Improved Measuring Techniques for Steam Generator Heat Absorption. *J. F. Cotter, F. C. Lisevick*, Combustion Engineering

2:00 p.m. Session 6—Instrumentation for Plant Performance Testing

CP61-984. Instrumentation for Central Station Dynamic Response Tests. *H. G. Dallas*, Phila. Elec. Co.; *D. Horwitz, R. L. Osborne*, Westinghouse Elec. Corp.

CP61-985. Digital Computer Application for Accurate Steam Turbine Performance Testing. *K. C. Cotton, J. C. Westcott*, General Elec. Co.; *T. J. Glass*, General Elec. Co.

Computer Processing of Heat Rate Test Data. *G. A. Maneatis, W. H. Barr*, Pacific Gas & Elec. Co.

Wednesday, September 27

9:00 a.m. Session 7—Turbine Generators

Save That Turbine—A Starting Technique. *J. R. Hamann, D. C. Parker*, Detroit Edison Co. (ASME Paper No. 61—PWR-1)

CP61-987. Transient Thermal Problems of Large Generators. *M. R. Lory, C. L. Wagner*, Westinghouse Elec. Corp.

Integrated Sea Water Distillation and Steam Power Generation Cycles. *E. H. Miller*, General Elec. Co.

GEYSERS Power Plant, America's first geothermal power plant, is the property of the Pacific Gas and Electric Company. This unique plant utilizes natural steam from the bowels of the earth to generate electric power. A trip will be made to this plant on the day after the National Power Conference.

Reliability Symposium To Convene in Washington, D.C. as International Body

FOR the 8th consecutive year the National Symposium on Reliability and Quality Control will convene this year, on January 9-11 at the Statler Hilton Hotel in Washington, D.C., as an international body gathering for "A Progress Report On Reliability," according to M. P. Smith, symposium chairman.

Mr. Smith, along with C. M. Ryerson, chairman of the Operations Committee, has been associated with the young field of reliability almost since its inception as an applied science. In 1960, Mr. Smith was also elected to the National Administrative Committee of the Institute of Radio Engineers' (IRE) Professional Group on Reliability and Quality Control.

In a review of the unique symposia by Mr. Ryerson, who heads a firm of product assurance consultants at West Collingswood, N. J., he recalled that Dr. Victor Wouk sparked the first symposium held in New York in 1954 under the sponsorship of the IRE Professional Group on Reliability and Quality Control.

Today, in addition to IRE, the symposium is backed by AIEE, the Electronics Industries Association, and the American Society for Quality Control.

The symposia grew from 400 attendees to current records in excess of 1,200 persons.

It was in 1956 that the theme, "A Progress Report On Reliability," was first adopted, and this has been the dominant theme at each session since.

The early work in systematizing reliability and quality control procedures came about in electronics, but Mr. Ryerson points out that, as it became obvious that the principles and techniques involved were as applicable to any industry, this emphasis has changed.

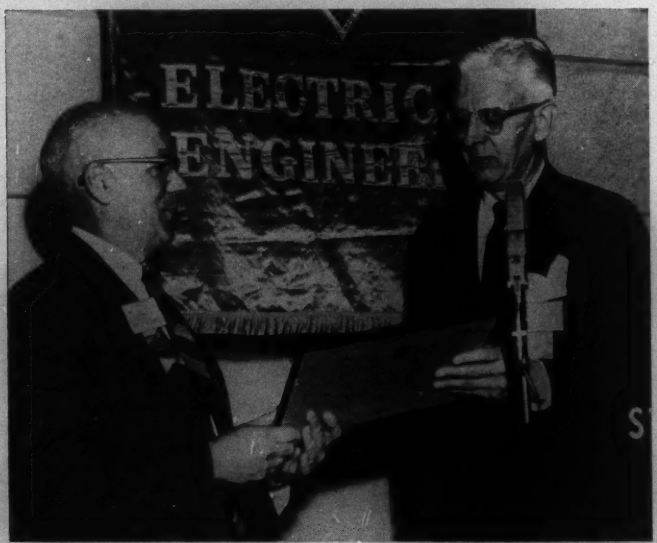
Another change in the atmosphere of the symposia has been an international one. Mr. Ryerson estimates that the international influence will increase in subsequent affairs; representatives and papers from these sources have been invited.

Mr. Smith has been selected as general chairman for the 8th symposium. He is presently manager of reliability at the Aeronautical Division, Military Products Group, for the Minneapolis-Honeywell Regulator Company.

The Advisory Board carries on its roster such names as U. S. Sen. H. M. Jackson, Rear Adm. L. D. Coates, chief of naval research, and Maj. Gen. L. I. Davis, commander of the Air Force Test Center at Patrick Air Force Base, Fla.

Other members are Dr. R. D. Huntoon, deputy director of the National Bureau of Standards; Capt. A. C. Packard, deputy director at the Federal Aviation Agency's Bureau of Research and Development; Dean J. M. Pettit, Stanford University; Rear Adm. L. B. Richardson of General Dynamics Corporation; Dr. R. C. Seamans, associate administrator for NASA (National Aeronautics and Space Administration) Headquarters; Dr. E. G. Witting, deputy director of research and development for the Department of the Army; and J. M. Bridges, director, Office of Electronics, office of the Director of Defense, Research and Engineering.

ATTENDING the opening luncheon of the North Eastern District Meeting were: (*left to right*) C. L. Derrick, vice-president of the Hartford Electric Light Company and vice-chairman of the meeting; Governor J. R. Dempsey, keynote speaker, and C. T. Hughes, meeting chairman.



A CERTIFICATE announcing his election to the grade of Fellow in the AIEE was presented to L. B. Grew (*left*) by AIEE Pres. C. H. Linder during the North Eastern District Meeting.

Gov. Dempsey Addresses North Eastern District Meeting

Keynoting the 3-day AIEE North Eastern District Meeting, held May 17-19 in Hartford, Conn., was an address by Gov. J. R. Dempsey, who told about 200 engineers at a luncheon meeting that the future growth and progress of the State of Connecticut are "absolutely dependent" on their technical contributions.

The Governor discussed the development of water, coal, and oil power for the state's factories, and said he hoped atomic power will soon be on a footing with the other sources. He discussed his plan for the establishment of a nuclear research center as follows:

"In any consideration of Connecticut's future, atomic energy stands out as a major potential contributor to her industrial growth and to the scientific research and development needed to spur that growth."

He spoke of the need to strengthen

the School of Engineering at the University of Connecticut and of the AIEE's student program.

"We may well say that the future of Connecticut depends on energy," the Governor stated, "electrical energy, atomic energy, and most important of all, human energy."

Sperry Award Winners Are Developers of Earth-Movers

Pioneers in the development of the giant earth-moving equipment that has made possible today's complex transportation system will receive the Elmer A. Sperry Award for 1961. One of the recipients, R. G. LeTourneau, is known as the father of giant earth-moving machines; another award winner will be the Research and Development Division of the Firestone Tire and Rubber Company, in recognition of its creation of the huge rubber tires which support such machines.

According to the announcement by R. B. Lea, on behalf of the Elmer A. Sperry Board of Award, "The Elmer A. Sperry Award for the year 1961 is made jointly to R. G. LeTourneau in recognition of his development of large-capacity, high-speed, automatic, earth-moving equipment and to the Research and Development Division of the Firestone Tire and Rubber Company in recognition of its pioneering the giant-sized heavy-duty tires which made such equipment feasible." The award, administered by five engineering societies, is presented for "distinguished engineering contribution which through application, proved in actual service, has advanced the art of transportation whether by land, sea or air." It will be officially presented on September 12 at a meeting of the Society of Automotive Engineers in Milwaukee, Wis.

Since the early 1920's, when he designed and began to build revolutionary earth-moving equipment, through World War II, when he was credited with producing more than half the heavy construction equipment used by the U. S. Armed Forces, Mr. LeTourneau has been an acknowledged leader in the field. Among the inventions and developments with which he is credited are the first grading machines to use a welded frame and the first to use rubber tires, electric control for wheels of scrapers, mammoth logging machines to carry 28 tons of logs over rough country, a "jungle destroyer" which crushes trees and undergrowth into a mat-like carpet, and special military vehicles capable of picking up stranded landing craft or disabled bombers and carrying them to safety in minutes.

Developments pioneered by the Firestone organization are credited with freeing earth-moving equipment from the metal wheels which once limited their effectiveness.

The Sperry Board of Award is composed of representatives of the AIEE, the American Society of Mechanical Engineers, the Society of Naval Architects and Marine Engineers, the Society of Automotive Engineers, and the Institute of Aerospace Sciences.

180 Technical Experts and Doctors Attend Biomedical Engineering Symposium

THE Symposium on Biomedical Engineering, held April 20-21 in San Diego, Calif., was attended by 180 technical experts and physicians from as far as the East Coast. Sponsored by AIEE, the Institute of Radio Engineers, and the Naval Hospital, this symposium was based on the theme "A New Frontier."

Thirty technical papers were presented during seven sessions covering subjects on Studies of Circulatory System, Circulatory Support Systems, Special Techniques, Bionics, Simulation of Biological Functions, and Instrumentation. A panel discussion session was held on "Biomedical Engineering—Today and Tomorrow," in which each panelist gave a 10-minute digest of the present status and the future of biomedical engineering in his field of interest.

Heart-Lung Machines Discussed

Dr. W. H. Lee, Jr., and Dr. James Maloney, both of the University of California Medical Center in San Francisco, created lively interest with their papers on what is wrong with heart-lung machines now in use. The papers were controversial in that they presented evidence that both prolonged extra-corporeal perfusion by currently used techniques and deep hypothermy bring about changes in the blood chemistry which can cause morbidity and even increased mortality. Other speakers disputed this evidence.

Dr. Maloney predicted only short-term interest in these matters in any case, because he anticipates that within the next 10 or 15 years we will have perfected some method of inducing suspended animation. This, he said, would not only allow surgeons to operate at their leisure, but might have other and seemingly more fantastic implications, such as the possibility of a person deciding to invest a comparatively small amount of money, go into hibernation for a generation or so, and wake up rich!

Dr. Lee explained that in the use of the machines the damage is done at the surface of the film of blood when it is presented to the air by the oxygenators. Oxygenators are devices which do the work of the lungs in restoring oxygen to the blood after it has been depleted by the cells of a patient's body.

John McLeod, Jr., a Convair engineer, exhibited a simplified heart-lung machine he has developed over the last 2 years. The machine, named MAC, combines the pumping and oxygenating function in one operation. A helix of plastic tubing, turning on a horizontal axis, partially loaded with blood and partially with air, performs both functions. It is a portable device, and Mr. McLeod estimated that it could be built and sold much cheaper than machines now on the market. He said the machine had been used in animal operations but probably would not be applied to human patients for at least a year.

Pacemakers Reviewed

Dr. E. I. Baranofsky, San Diego surgeon and clinical professor of surgery at the University of Southern California School of Medicine, reviewed the rapid advance in the development of pacemakers—devices for restoring the stimuli which cause the heart to beat after it has stopped. Some of the new ones he described are surgically attached to the heart and activated by external radio sets.

A banquet was held following the panel discussion on the first evening of this symposium. The *Proceedings* will be published. The symposium may be continued as an annual affair, possibly with the locations changed to other West Coast cities where biomedical interests exist.

International Conference on Magnetic Materials Planned

More than 1,000 scientists and engineers are expected to attend the 7th annual International Conference on Magnetism and Magnetic Materials, scheduled for November 13-16 at the Westward Ho Hotel in Phoenix, Ariz. AIEE is a co-sponsor of the conference.

Invited speakers include representatives from Russia, Japan, England, and France.

Dr. P. B. Myers, staff scientist for the Semiconductor Products Division of Motorola, Inc., is local chairman for the conference.

As in the past, the conference will emphasize the value of bringing together for discussion those interested in basic theory and practical application of magnetism.

Papers on basic theoretical and experimental investigations, potential engineering applications, and apparatus and techniques which utilize recent advances in magnetism are being solicited. Authors should submit abstracts by August 18 to Dr. F. E. Luborsky, General Electric Company, Research Laboratory, P. O. Box 1088, Schenectady, N. Y. Invited papers will be presented by eminent scientists and engineers both from the United States and abroad.

Dr. P. B. Myers

Also, as in past years, an exhibit of magnetic products and instrumentation is being sponsored by the conference.

Dr. L. R. Bickford Jr., scientist with the IBM (International Business Machines) Research Laboratories in Yorktown Heights, N. Y., is general chairman of the conference.

Dayton Section Presents Distinguished Engineer Award

Prof. P. A. Borden (AM '13, F '44, Member for Life) of the Electrical Engineering Department, University of Dayton, Dayton, Ohio, was presented with a Distinguished Engineer award by the Dayton Section, AIEE, at a special recognition meeting held for him on May 12 at the Engineers Club of Dayton.

He was introduced at the meeting by Dr. M. R. Graney, dean of engineering, University of Dayton, who described Prof. Borden's achievements. An author of several books on instrumentation, Prof. Borden is serving as student counselor at the University of Dayton for the Student Branch of AIEE and was the winner of the Morris Leeds National Award at the AIEE Fall General Meeting at Chicago, Ill., in October 1960.

Prof. Borden told of incidents that led to his interest in the electrical field, from his early youth through college and his experiences in industry.

The meeting opened with C. E. Huggins as chairman, who introduced C. A. Fisler, past chairman, who was in charge of all arrangements for the special meeting, and Mr. Fisler introduced Dr. Graney.

Other AIEE Fellows in attendance at the meeting were Charles Button (AM '26, F '56), Eugene Herzog (AM '23, F '48, Member for Life), Everett Larsh (M '44, F '58), and George Mueller (AM '29, F '50).

The meeting was preceded by a dinner for the honored guests, members, and their wives.

Industrial Electronics Symposium To Stress Manufacturer-User Relations

STRESSING co-operation between the electronic manufacturer and industrial user, the Joint Industrial Electronics Symposium, scheduled for September 20-21 at the Bradford Hotel, Boston, Mass., will attempt to foster a closer liaison and better understanding between the two groups.

Joint sponsors of the symposium are AIEE, the Professional Group on Industrial Electronics of the Institute of Radio Engineers, and the Instrument Society of America.

General chairman of the symposium is W. M. Trenholme of the Massachusetts Institute of Technology (MIT). His steering committee includes: Program Chairman—R. K. Jurgen, associate editor, *Electrical Engineering;* Arrangements Chairman—D. J. La Cerda, Badger Manufacturing Company; Finance Committee Chairman D. Z. Breck, Lynn Electric Company, and Publicity Committee Chairman—H. O. Painter, Jr., General Radio Company.

Luncheon Speakers Named

Luncheon speakers for the symposium are: Harold Chestnut, General Engineering Laboratory, General Electric Company, Schenectady, N. Y., and Dr. J. F. Reintjes, director of MIT's Electronic Systems Laboratory. On Wednesday at noon, Dr. Reintjes will discuss "Educating Engineers for Careers in Industrial Electronics." Mr. Chestnut, who will speak on Thursday, has chosen for his topic "The Role of Electronics in Industrial Automatic Control."

The panel discussion session, with W. E. Vannah of Foxboro Company as moderator, will cover many problem areas related to the use of electronic equipment industry. Panel members representing various segments of industry will discuss such topics as reliability of current industrial electronic equipment, trends in future equipment design, better methods for liaison between users and manufacturers, and preventive maintenance. Audience participation will be encouraged.

Advance programs, registration forms, and hotel reservation information may be obtained by writing D. J. LaCerda, Badger Manufacturing Company, 363 Third St., Cambridge, Mass.

Tentative Program Announced

Mr. Jurgen has announced the following tentative program:

Wednesday, September 20

9:00 a.m. Session I—Measuring Techniques for Industry

Chairman: Dr. C. W. Clapp, General Elec. Co.

Non-Contact Dimensional Measurements by Optical and Electronic Techniques. *C. D. Bryant,* Allen B. DuMont Labs.

Non-Destructive Testing of Materials and Components. *Paul Dick,* General Elec. Co.

Moisture Measurement in Industry. *H. W. Gebele,* Foxboro Co.

Analytical Instrumentation for Process Monitoring and Control. *H. J. Maier,* Perkin-Elmer Corp.

Electronic Devices for Measuring Flow. *D. R. Lynch,* Fischer & Porter Co.

12:00 noon Luncheon

Speaker: Dr. J. F. Reintjes, director, Electronic Systems Lab., MIT

Address: "Educating Engineers for Careers in Industrial Electronics"

2:00 p.m. Session II—Digital and Analog Techniques in Industry

Chairman: F. W. Atkinson, Owens-Corning Fiberglas Co.

Digital Control Techniques Applied to Automatic Weighing Processes. *D. W. Kennedy, C. W. Hibscher,* Toledo Scale, Div. of Toledo Scale Corp.

Digital Control of In-Line Blending. *C. A. Hill,* Packard Bell Computer

Blending by Analog Computers. *H. H. Roth,* Minneapolis-Honeywell Regulator Co.

Computer Control Practices and Preferences in Industry. *W. Mikelson,* General Elec. Co.

Electronic Guidance and Remote Control for Coal Mining. *K. L. Shrider,* Elec. and Engineering Co.

Thursday, September 21

9:00 a.m. Session III—Power Conversion Techniques

Chairman: C. H. Chandler, Gillette Safety Razor Co.

D-C to A-C Power Conversion by Semiconductor Inverters. *E. J. Duckett,* Westinghouse Elec. Corp.

An A-C Electric Transmission Drive for Turbine Powered Vehicles. *G. E. Pinter,* Jack & Heintz, Inc.

A 50-Kva Adjustable Frequency-24-Phase Controlled Rectifier Inverter. *C. W. Flairty,* General Electric Co.

Trends in Ultrasonic Machining Techniques. *R. P. Curtis,* Raytheon Co.

RECOGNIZED by the Dayton Section, AIEE, as a "Distinguished Engineer," Prof. P. A. Borden was presented with a certificate at a special meeting held in his honor. Shown are: (*left to right*) C. E. Huggins, chairman of the Dayton Section; Prof. Borden, and W. A. Dynes, a Section member.

Thermoelectric Applications to Industrial Problems. *J. C. R. Kelly*, Westinghouse Elec. Corp.

12:00 noon Luncheon

Speaker: Harold Chestnut, General Elec. Co.

Address: "The Role of Electronics in Industrial Automatic Control."

2:00 p.m. Panel Discussion of Manufacturer-User Problems

Moderator: W. E. Vannah, Foxboro Co.

Panel members: E. S. Ida, E. I. Dupont de Nemours & Co. (Chemical Processing); R. F. Sorenson, St. Regis Paper Co. (Paper Mills); Myer Fox, chairman, National Machine Tool Builders Assn., Lapointe Machine Tool Co. (Machine Tools); Arnold Shumaker, Jones & Laughlin Steel Co., and R. O. Bigelow, New England Elec. System.

Appliance Conference Slated for November 6 in Los Angeles

The 3rd Western Appliance Conference, sponsored by the Los Angeles Section of AIEE, will be held at the Biltmore Hotel, Los Angeles, Calif., on Monday, November 6.

The program is intended to be of value to everyone associated with electric and gas-fired appliances and their control equipment. Emphasis has been placed on the use of appliances of both gas and electric design when used in the ever-expanding field of mobile homes. All interested engineering, sales, and management people are invited to attend. Close association with the electrical industry or membership in the AIEE is not required.

The tentative program follows:

Morning Session

Conference Theme—"Dividend Engineering." *Maurice Fisher*, McCann Erickson

Value Engineering. *L. D. Miles*, General Elec. Co.

Reliability Studies. Speaker to be announced

Voltage Statistics at the Customer Service. *G. P. Tupper*, Westinghouse

Higher Customer Voltage Supply. Speaker to be announced

Luncheon

Speaker: Dr. Frederick Schwartz, Controls Co. of America

Subject: Solid State Products for Consumer Applications

Afternoon Session

Mobile Home Inspection. *R. A. Bahr*, State Division of Housing

Electric Demand Factor for Mobile Homes. *M. R. Mosquini*, Southern Calif. Edison Co.

Electrical Connections to Mobile Homes. *H. H. Watson*, General Elec. Co.

Gas Appliances for Mobile Homes. *Pieter Root*, Amer. Gas Assn.

Mobile Home Testing. *Herbert Witte*, Underwriters' Labs.

Dinner

Evening Session

The Mobile Home Park. *E. E. McRill*, Park Developer, Los Angeles, Calif.

Panel Discussion with audience participation on "Mobile Home Problems."

Moderator—Maurice Fisher
Panel—R. A. Bahr, M. R. Mosquini, H. H. Watson, Pieter Root, H. Witte

For further program details and registration forms write to: F. K. Cozens, c/o General Electric Co., 3325 Wilshire Blvd., Los Angeles, Calif.

Engineering Management Conference To Be Held September 14-15 in New York

THE 9th Annual Joint Societies' Engineering Management Conference will be held September 14-15 at the Hotel Roosevelt in New York City.

Through the joint efforts of members of AIEE and the American Society of Mechanical Engineers, it has been possible to assemble nationally recognized leaders concerned with the management of engineering resources to participate in the conference. Young engineers will be told of the rewards of increasing their skill and competence to become managers of engineering activities. Engineering managers are expected to find the conference a professionally rewarding experience because, in addition to meeting the speakers, they will have an opportunity to share ideas and experiences with other men in management.

Those who have planned this conference expect it to increase, if only in a small measure, every attendee's understanding of the relationship which must exist between engineering and management to provide for the welfare of the individual, the organization with which he is connected, and this country as it plans its role in the world today and in the future that lies ahead.

The tentative program follows:

Wednesday, September 3

Early Bird Social

Thursday, September 14

Session I—Advanced Techniques and Engineering Management

PERT: A Technique for Management. *K. M. Tebo*, General Motors Corp.

Statistics and Operations Research as Tools for Engineering Managers. *C. F. Kossack*, IBM.

Increased Profits through Application of Computer Technology. *W. W. Eaton*, C-E-I-R.

Luncheon

The Changing Personality of Today's Engineer. *I. N. Palley*, president, ITT Federal Labs.

Session II—The Expanding Interests of Engineering

Problems of Management in Foreign Countries. *George Browne*, "Industria."

The Economic Environment in Which Engineers Work. *Carl Madden*, Lehigh Univ.

Friday, September 15

Session III—Human Values in Management

Human Relations Problems in the Management of Engineering. *E. H. Schell*, MIT.

The Personal Approach in Dealing with Technical People. *H. L. Cox*, Corn Products Corp.

Enhancing Human Values during Institutional Change. *F. F. Bradshaw*, management consultant.

Luncheon

Recipient of Gantt Medal: Col. Lindell Urwick, England

Session IV—Management of Research

Problems of Administration of Research and Development. *H. C. Vernon*, E. I. du Pont de Nemours & Co.

Management of Research and Development Personnel in an Industrial Laboratory. *R. B. Mears*, U.S. Steel Corp.

Technical Papers Invited for Solid-State Circuits Conference

The 9th annual International Solid-State Circuits Conference will be held February 14-16 on the campus of the University of Pennsylvania and at the Sheraton Hotel, Philadelphia, Pa.

The conference, sponsored jointly by AIEE, the Institute of Radio Engineers, and the University of Pennsylvania, will feature papers dealing with circuit properties, circuit philosophy, and design techniques related to solid-state devices in general areas, such as:

Solid-state memory; storage, and logic.

Solid-state microwave amplification, oscillation, and conversion.

Solid-state devices performing an integrated circuit function.

Unconventional power supplies.

Cryogenic applications.

Optoelectronic applications.

Advanced circuitry, with emphasis on significant developments in the art.

Papers representing original contributions in these and related fields are invited.

Abstracts, highlighting the nature of the contribution, its significance in the art, and theoretical and experimental results, 300 to 500 words in length, which can be accompanied by key illustrations, should be submitted on single-side, black on white, double-spaced typewritten form suitable for immediate reproduction, on or before November 1, 1961, to the program committee secretary: R. H. Baker, Room C-237, MIT (Massachusetts Institute of Technology) Lincoln Laboratory, Lexington, Mass.

Abstracts should be accompanied by author's name, affiliation, address, and telephone contact on the first page, and author's name and abbreviated paper title on each subsequent page.

Members of the 1962 conference committee include: Chairman—J. J. Suran, General Electric Company; Secretary—E. G. Nielsen, General Electric Company; Program Chairman—R. B. Adler, MIT, and Public Relations—Lewis Winner, New York, N.Y.

Optical Maser Discussed at Meeting of Virginia Section

The Virginia Section, AIEE, had a discussion and demonstration of the Optical Maser by W. L. Bond of the Bell Telephone Laboratories at the Section's May meeting in Richmond, Va.

During the meeting, Certificates of Appreciation were presented to L. R. Quarles, dean of engineering, University of Virginia, who is Section chairman, and G. R. Lufsey, underground lines superintendent, Virginia Electric and Power Company, who is Richmond Subsection chairman.

POSING with the banquet speaker, Lt. Cdr. Guy Shaffer *(in uniform)*, U. S. Navy, at the first Packaging Industry Conference are: *(Standing, left to right)* R. A. Pfuntner, chairman, Lynn Section; I. E. Eliasson, secretary; E. B. Gardner, program chairman. *(Seated, left to right)* D. R. Percival, chairman, General Industry Applications Committee; J. D. Ramsay, chairman, and F. R. Cinco, vice-chairman. Lt. Cdr. Shaffer told of Arctic research and exploration conducted by the atomic submarine "Skate."

Packaging Industry Conference Held May 15-16 at Swampscott, Mass.

MORE than 140 representatives of packaging machinery manufacturing companies, electrical equipment manufacturers, and users of packaging machinery attended the First Packaging Industry Conference, May 15-16, at Swampscott, Mass.

The conference was organized to discuss problems arising through greater electrification of packaging machinery and pointed up by increasing adoption of semiautomatic and fully automatic equipment to package the nation's products.

E. W. Dacey, Procter and Gamble Company, who addressed the conference, stated that the AIEE Packaging Industry Subcommittee "offers an excellent chance to improve the relationship of user, manufacturer, and electrical supplier, because it offers a means of improving communications between all interested parties."

Mr. Dacey counselled that preparation of suitable standards presented a real challenge because of the variety of equipment and machinery involved. He declared that standards will be extremely valuable as a base specification that can be used in part or in its entirety to describe the machinery user's wants in a language understandable to both parties.

C. M. Rhoades of the General Electric Company advised the conference that AIEE appears to provide the necessary focal point for any study of the need for electrical practices in the packaging industry.

Representing the machinery manufacturers' view, Boyce Brandon, Emhart Manufacturing Company, urged the standardization of the cataloging of components and the presentation of specifications.

Trends in the electrification of packaging machinery were traced by T. W. Brockmeier of the engineering department, National Biscuit Company. V. F. Sepavich, Crompton and Knowles Corporation, explained how electrical standards are formed for the textile industry.

Other subjects covered included wiring diagrams, symbols and circuitry control enclosures and panel wiring methods, conduit and wiring systems for packaging machinery, short-circuit protection, clamp on heaters, cartridge heaters, cast-in heaters, high-frequency heat, impulse heating limit switches, selection and application of solenoids, and photoelectric registration. Two new products forums were included in the four general sessions.

Luncheon speakers were L. H. Zahn, president, Packaging Institute, and W. W. Anthony Jr., vice-president, Packaging Machinery Manufacturers Institute.

The general chairman of the conference was J. D. Ramsay, Campbell Soup Company, and program chairman for the conference was E. B. Gardner, Emhart Manufacturing Company. Session chairmen were: M. H. Fisher, Westinghouse Electric Corporation; Don Percival, Machinery Electrification, Inc.; Ira Gottscho, Adolph Gottscho Inc., and Thursten Clarke, Food and Drug Packaging Magazine.

At a meeting of the Packaging Industry Subcommittee, the following were elected for the year 1961-62: Chairman—Frank Cinco, Package Machinery Company; vice-chairman—I. E. Eliasson, Machinery Electrification, Inc., and secretary—Thursten Clarke, Food and Drug Packaging. A vote of appreciation for his excellent work was accorded J. D. Ramsay, retiring chairman.

The Packaging Industry Subcommittee has been working on actual standardization procedures.

Conference Scheduled on Electronic Components

The 12th annual Electronic Components Conference, sponsored by AIEE, the Electronic Industries Association, and the Institute of Radio Engineers, and with participation by the American Society for Quality Control and the Society for Nondestructive Testing, will be held May 8-10, 1962, in Washington, D. C.

This meeting is devoted to new developments in components, component-processing techniques, component evaluation, and component materials. The following topics suggest the scope of interest:

Classical Components: R, L, C, linear and nonlinear, lumped and distributed.

Combined Function Devices: Integrated thin film circuits, multiple semiconductor devices, miniature modules.

Solid-State Applications: Ferroelectric, ferromagnetic, thermoelectric, magnetic optic, electroluminescent.

Magnetics: Square-loop components, memory devices, magnetic films, magnetostrictive devices.

Electromechanical Devices and Concepts: Switching devices, filters, delay lines.

Microwave Components

Filters and Networks

Connecting Devices and Techniques

Processing, Assembly and Measuring Techniques

Nondestructive Testing

Component Reliability

Electronic Materials

Component-Systems Planning and Integration.

Authors are invited to submit a 500-word summary before the October 9 closing date to H. A. Stone, chairman, Technical Program Committee, Bell Telephone Laboratories, Murray Hill, N. J. To expedite prompt handling, 15 copies are requested. Authors will be notified of acceptance about November 15.

Final papers will be due on January 15 and will be published in the *Proceedings* of the conference.

'Live' Exposition To Be Integrated with Technical Sessions at Winter Meeting

THE influence of television is bringing about a change in the traditional pattern of technical and scientific meetings, according to Nelson Hibshman, Executive Secretary of AIEE, who is planning the AIEE Winter General Meeting to be held Jan. 29–Feb. 2, 1962, in New York.

"Television," said Mr. Hibshman, "has turned us from a nation of listeners to a nation of viewers. There was a time when the individual who came to a technical or scientific meeting was satisfied to sit and listen. Today, in addition to listening to the presentation of a technical paper, he wants to see its application and the tool, machine, or process making the application of its basic idea possible."

To satisfy this growing demand for visual demonstrations, the AIEE Executive Secretary said that the industry-wide Electrical Engineering Exposition, sponsored by the AIEE, to be held at the New York Coliseum in conjunction with its Winter General Meeting, is being planned as an integral part of the technical sessions.

"Electrical-electronic engineers," Mr. Hibshman said, "will be able to go from the technical sessions right into the exhibit areas and see actual demonstrations of the principles, procedures, and materials they have heard discussed.

AIEE cordially invites the more than 3,000 firms that provide the electrical-electronics industry with nearly 200 different products and services to participate in the first Electrical Engineering Exposition—to take advantage of this unparalleled opportunity to demonstrate their progress in equipment production to the high-level executives, engineers, and scientists who comprise the AIEE membership."

H. F. Grebe, exhibits manager of the Reber-Friel Company of Philadelphia, Pa., nationally known exposition management firm in charge of the Exposition, said the Exposition will definitely supplement the technical program of the AIEE Winter Meeting.

He said two entire floors of the New York Coliseum have been reserved for the Exposition and the technical meeting so that technical sessions can be held in special meeting rooms near the exhibit areas.

The Electrical Engineering Exposition, Mr. Grebe said, will cover the complete spectrum of equipment, products, and services of every branch of the electrical-electronics industry. Firms that have already decided to exhibit range from manufacturers of complete electrical assemblies to companies making small component parts.

"The Exposition itself will have a professional atmosphere about it," stated Mr. Grebe. "The exhibits will be staffed by engineers. Visiting engineers will be able to discuss their problems and needs right on the spot. They will be able to examine the products, materials, and services displayed, see them demonstrated, and thus be able to decide how they might fit into their own requirements."

Mr. Grebe said that in personal interviews with registrants attending a previous AIEE Winter General Meeting, 70% of the engineers expressed a strong desire to see a nationwide trade exposition supplement the technical sessions.

He said the engineers interviewed pointed out that in addition to the ideas they normally obtain at AIEE technical meetings, they want to see first-hand demonstrations of the products, materials, and services they will need to implement these ideas.

"Another important reason that these engineers are so strongly in favor of an Exposition," Mr. Grebe said, "is their need to familiarize themselves with the many new products, materials, and services available in the field so that they may intelligently help make the purchase decisions for their firms."

Mr. Grebe said that approximately 25% of the available exhibit space has already been reserved and is being assigned on a "first-come, first-served" basis.

Detailed information about the Electrical Engineering Exposition may be obtained from the Reber-Friel Company, 117 S. 17th St., Philadelphia 3, Pa.

Subcommittee To Print Papers that Accomplish Its Aims

The Carrier Bibliography Subcommittee of the Power System Communications Committee is attempting to publish semi-annually a listing of all printed material, whether presented as a technical paper at a local conference, at a regional meeting, as a report, or in any other form which will accomplish the aims of the committee.

The Power System Communications Committee is one whose scope is the treatment of all matters in which the dominant factor is the transfer of intelligence of electrical means for the control of generation, transmission, and distribution of power involving the study of integrated communications for power systems, methods of measurement, and protection of communications circuits and equipment.

It is also concerned with the application and co-ordination of communication equipment as required for the function of facsimile, load control, pilot relaying, transfer-trip, supervisory control, telemetering, teletypewriter, voice communication, and data transmission.

The mediums by which these functions are transmitted, audio tones, power line and telephone line carrier, microwave radio, space radio (UHF), and telephone lines and cables are also within the scope of this committee.

The design, construction, and application of power line carrier equipment including transmitters and receivers, coupling and tuning devices, and line traps are also of interest.

The committee is requesting any individuals, association, committees, sectional representatives or other interested organizations to inform it of any items of interest which would or could be made available in some form to those requesting it.

These items should be forwarded to: A. N. Robertson, chairman, Carrier Bibliography Subcommittee, American Electric Power Company, 2 Broadway, New York 8, N. Y.

The following information should be included:

1. Title of article
2. Author
3. Scope
4. Where first presented or published
5. Availability
   (a) limited
   (b) cost or no cost
6. Copy of article if possible
7. Procedure for procuring copies

These references, if of lasting interest and readily available, will be listed permanently in the Carrier Bibliography Transaction Paper, or, if availability is limited, only on the semiannual listing.

Milwaukee Section Elects New Officers for 1961-62 Year

Officers for the 1961-62 year were unanimously elected at the June 8 general meeting of the Milwaukee Section, AIEE.

R. E. Horn was named chairman; J. M. Frank, vice-chairman; G. H. Manke, secretary, and H. E. Whiting, treasurer. Robert Rech, R. A. Niles, and Augustus Lehrkind were elected directors for 3 years.

Mr. Horn has been active in the Milwaukee Section as chairman of the Publicity and Membership Committees and has also served as a director, secretary, and vice-chairman of the Section.

C. E. Pflug, plant manager at American Motors, was presented with a Fellow certificate by B. G. Wheeler, chairman at the June meeting.

R. E. Horn

Camera Associates

ATTENDING the unveiling of the bust of Thomas Alva Edison at the Hall of Fame for Great Americans at New York University on June 4 were: (*left to right*) Gen. David Sarnoff, chairman of the Radio Corporation of America and trustee of New York University and the Thomas Alva Edison Foundation; Miss Mary Pickford, trustee, Thomas Alva Edison Foundation; Mrs. Madeleine Edison Sloane, daughter of Thomas Alva Edison, and Charles Edison, former Governor of New Jersey and son of the inventor.

Bronze Bust of T. A. Edison Unveiled at NYU's Hall of Fame for Great Americans

A BRONZE BUST of Thomas Alva Edison (HM '28) was installed in the Hall of Fame for Great Americans on the New York University (NYU) campus in the Bronx on June 4.

Edison, developer of the first practical electric light, the phonograph, the motion picture camera, and other inventions, became the 86th individual to join the immortals whose busts line the colonnade of the national shrine.

Fashioned by the sculptor Bryant Baker, the bust was unveiled by two of the inventor's children, Mrs. Madeleine Edison Sloane and Charles Edison who is a former Governor of New Jersey and former Secretary of the Navy.

RCA Chairman Is Speaker

Brig. Gen. David Sarnoff, chairman of the Radio Corporation of America (RCA) and a trustee of the Thomas Alva Edison Foundation which sponsored the ceremony, led the tribute to the inventor whom he described as "the father of modern research."

"Edison's message for our time," he said, "is that we must work as a team but we must not lose our sense of the uniqueness of man's genius, of the supreme value of the individual. In this lies our best safeguard against the deadly regimentation of Communism. It is our best hope for a future of peace, abundance, and freedom."

Edison Lauded for His Method

Gen. Sarnoff declared that Edison's "greatest invention, the one most productive and most instructive for our times, was not a single piece of equipment but a unique method of innovation."

"It was Edison who first conceived the idea of assigning teams of gifted workers to find 'a way to do it better,'" he said.

"In systematizing the quest for new knowledge, he became the father of modern research.

"At Menlo Park, just 85 years ago this Spring, Edison established the world's first industrial research laboratory. Today, the results of that imaginative enterprise are imperishably evident."

Edison was one of the founders of AIEE and served as an Institute vice-president (1884-85). He was elected to honorary membership in 1928.

Other speakers at the ceremony in the Hall of Fame included: Miss Mary Pickford, former screen star and a trustee of the Thomas Alva Edison Foundation; H. S. Firestone, Jr., chairman, Firestone Tire and Rubber Company; S. R. Knapp, president, Edison Electric Institute; W. L. Cisler, president, Detroit Edison Company and Edison Foundation; T. W. Martin, chairman, Alabama Power Company, and Giorgio Valerio, managing director, Societa Edison, Milan, Italy. Dr. R. W. Sockman, director of the Hall of Fame, presided at the ceremonies.

Colleges Award Degrees and Honors to Prominent Engineers

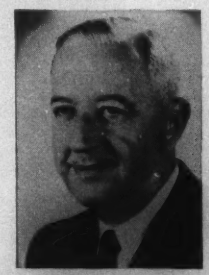
Prominent engineers were awarded degrees and honors in June by various educational institutions.

H. L. Logan (AM '19, F '43, Member for Life), vice-president in charge of research for the Holophane Company, Inc., was awarded the honorary degree of Doctor of Laws by Iona College, New Rochelle, N. Y., at the June 3 commencement. Dr. Logan was cited for his pioneering contributions as inventor, author, and lecturer to the science of illumination and its applications.

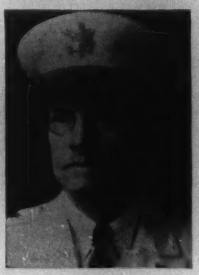
The Marston Medal, awarded annually to an outstanding Iowa State University engineering alumnus, was presented June 3 to Brig. Gen. W. A. Danielson (AM '09, M '30, Member for Life). A 1907 graduate in electrical engineering, Gen. Danielson served almost 40 years in the Army, during which he was engaged in construction, maintenance, and operation of Army installations. He retired from the Army in 1946.

H. I. Tarpley (AM '24, M '49), professor of electrical engineering, has been named 1961 recipient of the President's Award for Outstanding Teaching at Pennsylvania State University. This award, inaugurated in 1958, annually goes to one or more members of the faculty "in recognition of devoted service as a conscientious and outstanding member of the teaching faculty." Prof. Tarpley was presented with an engraved plaque and $1,000 stipend to each recipient at the June 10 commencement exercises.

F. A. Rojak (AM '49) of Stoneham, Mass., received the M.S. degree in electronic engineering on June 11 at the commencement exercises of Lowell Technological Institute.

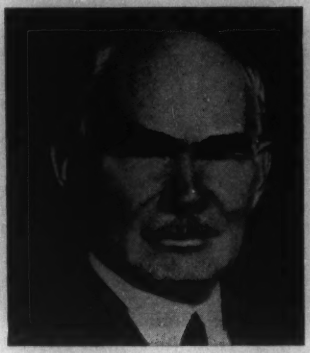


H. L. Logan



W. A. Danielson

Inventor of 3-Element Audion Tube Dies after Achieving Professional Renown



Lee De Forest

LEE DE FOREST (AM '04, M '07, F '18, Member for Life), a figure of momentous influence in the communications field, and inventor of the audion tube which led to the foundation of the radio industry and long-distance telephone communication, died June 30 at the age of 87.

He was granted a patent in 1907 for the tube which was intended to be an improvement on "space telegraphy." Later, the tubes made possible the development of radar, television, talking motion pictures, and other applications in electronics.

Dr. De Forest was the recipient of AIEE's 1946 Edison Medal Award. He was cited "for pioneering achievements in radio and for the invention of a grid-controlled vacuum tube with its profound technical and social consequences."

Born Aug. 26, 1873, in Council Bluffs, Iowa, he graduated from the mechanical engineers course of the Sheffield Scientific School at Yale University with the degree of Ph.B. in 1896. He took 3 years of post-graduate work in electricity, physics, and mathematics at Yale where he received a Ph.D. degree in 1899, with his thesis "Reflection of Hertzian Oscillations at Ends of Parallel Wires."

Dr. De Forest worked in the Telephone Laboratory of the Western Electric Company, Chicago, Ill., from 1899 to 1900, when he was also on the editorial staff of *Western Electrician* in Chicago.

He spent one year, 1900-01, in experiments on wireless telegraph receivers in the laboratories of the Armour Institute, Chicago, where he developed the electrolytic "responder."

In the summer of 1901, he built an apparatus operated by the Publishers Press Association in reporting the International Yacht Races.

Upon organization of the De Forest Wireless Company, he took charge of the development of the wireless telegraph system known by his name. In subsequent years, he installed wireless apparatus for the U. S. Signal Corps, the U. S. Army, and the U. S. Navy.

He conducted tests in 1903 between Wales and Ireland, and he equipped a dispatch boat for the *London Times* war correspondent reporting naval operations in the China Sea.

His system by which overland communication was established from St. Louis, Mo., to Chicago and Kansas City, Mo., was exhibited at the World's Fair in St. Louis. The system was awarded the Grand Prize and Gold Medal by the Commission of Awards and he was awarded a Gold Medal.

In 1906, Dr. De Forest inserted a zigzag piece of platinum wire between the filament and plate of a valve detector. He called it a "trigger" or "grid" and named the new 3-element tube the "Audion."

In 1912, he approached Western Electric engineers with his grid-controlled amplifier for the purpose of using it in long-distance lines, and particularly in transcontinental services. Within 2 years, transcontinental telephone service was established.

The audion tube was developed further by the Radio Corporation of America in the field of radio communication and in the production of receiver-amplifier tubes, by the General Electric Company in giant power tube design, and by the Westinghouse Company in its application to industrial uses. The tube, with its manifold circuits, has produced the talking picture, the living reproduction of recorded music, and television.

B. R. Teare, Jr., Selected To Fill Term of R. B. Gear as Director-at-Large

B. R. TEARE, JR. (AM '29, F '42), dean of the College of Engineering and Science at the Carnegie Institute of Technology, has been named AIEE Director-at-Large to replace R. B. Gear who died recently. Dr. Teare will serve for the term ending July 31, 1961.

A native of Wisconsin, he was educated at the University of Wisconsin, where he received the B.S. and M.S. degrees in 1927 and 1928, respectively, and at Yale University where he completed his doctoral work in 1937.

In 1929, he joined the General Electric Company as a student electrical engineer and took the company's Advanced Course in Engineering.

Dr. Teare taught at Yale during 1933-39, and joined the Carnegie faculty in 1939 with responsibility for organizing a program of graduate study in electrical engineering. He was made head of the Department of Electrical Engineering in 1944, dean of Graduate Studies in 1950 and 2 years later assumed his present position as dean of the College of Engineering and Science.

He has done research on the subjects of hysteresis motors and copper-covered steel conductors at high frequencies, and has been active in a number of national projects in engineering education.

B. R. Teare, Jr.

A Fellow in the Institute of Radio Engineers, he served as president of the American Society for Engineering Education in 1959-60 and was vice-president of the society during 1953-55.

Dr. Teare received the George Westinghouse Award for 1947 in recognition of his contributions to engineering education. Known for his pioneering work in the development and co-ordination of engineering courses, he is also a leader in the effort to design college programs which will give students competence in human and social as well as the technical fields.

A former AIEE District 2 vice-president (1957-59), Dr. Teare has served on the following AIEE Committees: Edison Medal (1951-56, 1959-64), Professional Development and Recognition Department (1956-61), Research (1960-61), Publication (1948-50), Technical Program (1948-50), Education (1941-60, chairman 1948-50), Professional Group (1948-49), Electrical Machinery (1937-42), and Communication (1934-36).

311 Persons Attend Cement Industry Conference

Registration of 311 persons was recorded at the 3rd AIEE Cement Industry Conference, sponsored by the Cement Industry Subcommittee of the AIEE General Industry Applications Committee and the Michigan Section, and held April 18-20 in Detroit, Mich.

The conference was represented in the Detroit area with several manufacturing and distribution plants. Four technical sessions included the presentation of 21 papers on maintenance and safety, automation, electric drives, and power distribution, as related to the cement industry.

A luncheon was held at which R. B. Martin, president of Dundee Cement, was the guest speaker. The banquet was

addressed by C. B. Baker, president, Universal Atlas Cement Division, United States Steel Corporation, who spoke on "Permanence of Change."

Two plant tours were conducted, one to Dundee Cement and the other to Enrico Fermi Atomic Power Plant.

Each registrant received a bound volume of all the papers at the registration desk. Additional copies may be obtained at $8 each by mailing a request with remittance to B. H. Schneider, Detroit Edison Company, 2000 Second Ave., Detroit 26, Mich.

Automatic Control Conference To Be Held June 28-30 at NYU

The Joint Automatic Control Conference will be held June 28-30, 1962, at New York University, University Heights, Bronx, N.Y. The conference theme, "Integrated Automatic Control Systems," will highlight the many significant subsystem integration problems raised by the major current trend toward control system centralization. While particular emphasis will be placed on the synthesis, analysis, implementation, and operation of integrated automatic control systems, classical control frontiers will also receive significant attention.

General chairman of the conference is Dr. A. S. Robinson, director of research, Kollsman Instrument Corporation, 80-08 45th Avenue, Elmhurst 73, N. Y. A. J. Hornfeck, director of research, Bailey Meter Company, 1050 Ivanhoe Road, Cleveland 10, Ohio, is to be the program chairman.

Prospective authors are invited to contact the program chairman for further details.

UEC Building To Be Occupied Soon by 19 Engineering Societies and Agencies

BEFORE the Summer wanes, American engineering will be quartered in its new home, the United Engineering Center (UEC), a 20-story building on New York's East Side, between 47th and 48th Streets facing United Nations Plaza.

The 19 major engineering societies and agencies to be tenants of the new building are expected to make the physical move to the new address in late August or early September. About 650 headquarters personnel will be involved in the shift of the offices of the societies, which have a combined membership of more than 300,000 engineers.

Thirteen of the engineering organizations, including the Engineering Societies Library and Engineering Index, will be leaving the present engineering building, 29-33 W. 39th St., New York 17, N.Y., which has been home for most of them for more than 50 years. The other organizations, which are not now tenants of the present building, will move to UEC at about the same time.

Formal dedication of the new building, with appropriate ceremonies, is expected to take place in October. Committees have already been formed and are planning for the dedication. The General Committee is composed of L. C. Kemp, Jr., J. F. Fairman, C. E. Davies, W. G. Bowman, Andrew Fletcher, and W. H. Wisely, with the last-named serving as chairman. Other committees at work are the Operating Committee, composed of public relations personnel of the various societies, and a Committee of Editors of the society publications.

In addition to the formal dedication, the program, according to tentative plans, will include an open house and inspection of the new building.

All except two floors, the 15th and 16th, will be occupied when the move is completed. These will remain vacant for possible expansion of the tenant societies, or to be available for other societies.

The main entrance to the building is on 47th Street; besides an attractive marble-walled lobby, the ground floor has a large auditorium with a seating capacity of 450, an exhibit area of more than 6,000 square feet, and a main lounge. A large cafeteria and several private dining areas occupy the lower level.

The Engineering Societies Library, often called the most comprehensive engineering library in the world, and Engineering Index will occupy the second floor and other subfloor areas for stacks. These areas are reached with a special elevator.

Occupants of other floors will be:

3rd floor—United Engineering Trustees, Inc., Engineering Foundation, Engineers Joint Council, Society of Women Engineers, American Institute of Consulting Engineers, Engineers Council for Professional Development, Municipal Engineers of the City of New York.

4th floor—American Institute of Industrial Engineers, American Society of Heating, Refrigerating and Air-Conditioning Engineers.

5th, 6th and 7th floors—American Society of Mechanical Engineers.

8th floor—Welding Research Council, American Welding Society.

9th floor—Illuminating Engineering Society.

10th and 11th floors—AIEE.

12th floor—American Institute of Chemical Engineers.

13th and 14th floors—American Institute of Mining, Metallurgical and Petroleum Engineers.

15th and 16th floors—Vacant and unfinished, for future expansion.

17th and 18th floors—American Society of Civil Engineers.

19th and 20th floors—To be used for mechanical equipment.

WELDED steel framing is utilized throughout the UEC building, with exterior walls predominately curtain wall construction. Clear glass and blue-tempered spandrel glass, divided into rectilinear patterns by stainless steel mullions and column sheathing, enclose most of the tower, which houses the offices. Two tower corners and a considerable expanse of base building wall are faced with limestone. Funds for the $12 million building were raised through a member gifts campaign and from industry. AIEE is expected to move to the new address in late August or early September.

Fellowship Is Awarded to Cornell Graduate Student

George Kovatch (AM '61), Cornell University graduate student, has been awarded a fellowship for the coming academic year by the Foundation for Instrumentation Education and Research. Under the fellowship, he will continue work for the Ph.D. degree at Cornell, with his major in automatic control systems engineering and his minor in electrical engineering and mechanics. The fellowship is sponsored by Electronic Associates, Inc., in co-operation with the Foundation.

AIEE FELLOWS ELECTED

Board of Directors Meeting, April 28, 1961

Harrison R. Armstrong (AM '37, M '43), principal engineer, general engineering department, Detroit Edison Company, Detroit, Mich., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to insulation co-ordination and transient over-voltage protection." Born in Lancaster, N. Y., on January 17, 1903, he received the B.S. degree in electrical engineering in 1925 from the University of Idaho. That year, Mr. Armstrong joined the General Electric Company where he participated in the test course. In 1928, he went to work for Detroit Edison as a field engineer in the electrical system department. During this period, Mr. Armstrong directed many studies on lightning protection and protective grounding. In 1957, he was transferred to the general engineering department where he became responsible for the development of standards and practices pertaining to protective grounding, system insulation, and overvoltage protection. Mr. Armstrong is a member of the Michigan Society of Professional Engineers, the Engineering Society of Detroit, and is a registered professional engineer of the State of Michigan. He was chairman of the Michigan Section, AIEE (1955-56) and has served on the AIEE Protective Devices Committee (1955-61, chairman 1958-60) and Power Division Committee (1958-60).

Charles Francis Avila (M '44), president and general manager, Boston Edison Company, Boston, Mass., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the design and improvement of underground electric distribution systems." Born in Taunton, Mass., on September 17, 1906, he was educated at Harvard University from which he received the B.S. degree in electrical engineering and business administration in 1929. He joined Boston Edison that year. In 1954, he became assistant to the president of the company, and subsequently was advanced to vice-president in charge of engineering and construction, vice-president and assistant general manager, corporate vice-president and assistant general manager, and in 1960, was named to his present position of president and general manager. Mr. Avila is a director of Boston Edison, the Associated Industries of Massachusetts, the Edison Electric Institute, the Electric Council of New England, and the Yankee Atomic Electric Company. A registered professional engineer of the State of Massachusetts, he is a member of the Association of Edison Illuminating Companies, the Harvard Engineering Society, and the Underground Systems Reference Book Review Board. Mr. Avila has served on the AIEE Insulated Conductors Committee (1947-55).

Roy E. Bradstrum (M '49), chief engineer, Michigan Bell Telephone Company, Detroit, Mich., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to operation, refinement and expansion of a major telephone utility." He was born August 23, 1899, in Eau Claire, Wis. Mr. Bradstrum began his career with Michigan Bell at Saginaw in 1921 as a traffic student. After a series of supervisory positions in the traffic department, he was placed in charge of all central office and interoffice trunk engineering in 1930. He was named general traffic engineer in 1944, and 3 years later was transferred to the general engineering department as building and equipment engineer. Mr. Bradstrum was appointed plant extension engineer in 1951, and in 1953 temporarily assumed the duties of chief engineer. The following year, he was loaned to the American Telephone and Telegraph Company on a special assignment. He returned to the executive department as assistant vice-president in 1955, responsible to the general manager, and assumed his present duties as chief engineer in 1956. Mr. Bradstrum is a member of the Engineering Society of Detroit and the Rapid Transit Commission of the City of Detroit.

Harry Hamilton Cochrane (M '43, Member for Life), engineering consultant, Montana Power Company, Butte, Mont., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to economical power generation and transmission for an extended system." Born December 3, 1880, in Hartford, Conn., he was educated at Trinity College from which he received the B.S. degree in 1901 and at Cornell University where he was awarded the M.M.E. degree in 1906. He went to Cornell in 1904, first as laboratory assistant and later as instructor in electrical engineering. In 1906, he was employed as an electrical engineer by the Missouri River Power Company in Montana and later by the Butte Electric and Power Company. When these companies merged into the Montana Power Company in 1912, Mr. Cochrane became chief engineer of the latter company and held this position until 1949 when he was retired. Following retirement, he was retained as a consultant. In 1956, Mr. Cochrane was honored by the Montana Power Company when they gave his name to a 60,000-kw hydro plant on the Missouri River near Great Falls, Mont., at the time the construction of the hydro plant was started.

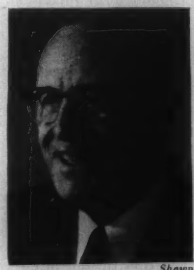
H. H. Cochrane

Earl Stilson Condon (AM '35, M '42), managing partner and president of the Earl S. Condon Company, Los Angeles, Calif., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to power insulator improvement and protective and distribution equipment for aircraft." He was born March 31, 1892, in Bangor, Me. During 1920-24, he was employed by the Pacific Telephone and Telegraph Company, a division of the American Telephone Company, as an engineer. While on the telephone company's payroll, he was loaned to the U. S. Army Signal Corps to serve as an observer monitoring incoming and outgoing lines for conversations which would now be considered classified. Mr. Condon was employed in the capacity of sales and application engineering, with emphasis on

H. R. Armstrong

C. F. Avila

R. E. Bradstrum

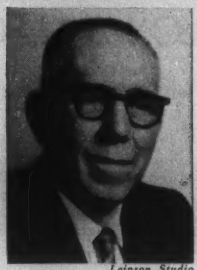


Shawn

E. S. Condon

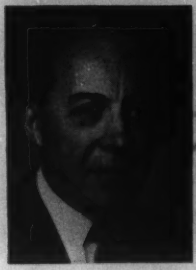
N. E. Dillow

B. J. Ennis



Lainson Studio

C. C. Ernst



C. F. Green

application engineering, in 1924-37, for Baker-Joslyn Company and Maydwell and Hartzell, Inc., successively. He has been managing partner and president of the Earl S. Condon Company since 1941. A registered professional engineer in electrical engineering in the State of California, he is a member of the National Electric Equipment Representatives Association, the Pacific Coast Electrical Association, the Los Angeles Maintenance Engineers Association, and the Los Angeles Aerospace Society. He is a past chairman of the Los Angeles Section, AIEE (1947-48).

Noel Eugene Dillow (AM '40, M '48), general manager—Bushing Products Section, power transformer department, General Electric Company, Pittsfield, Mass., has been transferred to the grade of Fellow in the AIEE ". . . for contribution toward the optimization of transformer design through the use of computers and standardized components." A native of Dongola, Ill., he was born August 2, 1918. He graduated from the University of Illinois in 1939 with the B.S. degree in electrical engineering. After graduation, he worked as an engineer for the Illinois Power Company and Central Illinois Public Service Company. During October 1944-46, he served as a lieutenant, junior grade, in the U. S. Navy, assigned to radar engineering in the Electronic Field Service Group of the Naval Research Laboratory. Upon his release from naval service, he went to the General Electric Company as an application engineer in the Central Station Engineering Department, Schenectady, N. Y. He subsequently transferred to the power transformer department, Pittsfield, Mass., and became manager—Marketing Research, Product Planning and Marketing Administration. He was later appointed, in succession, manager—Power Transformer Engineering, and manager—Marketing for the department. In 1961, he was appointed to his present position of general manager—Bushing Products Section in the power transformer department. He is a registered professional engineer in the State of Illinois and a member of Tau Beta Pi and Eta Kappa Nu.

Bruce James Ennis (AM '37, M '46), associate, Burns and McDonnell Engineering Company, Kansas City, Mo., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the design and construction of electric power supply systems." Mr. Ennis was born in Kansas City, Mo., on December 9, 1910. He received the B.S. degree in electrical engineering from the Massachusetts Institute of Technology in 1933. He joined Burns and McDonnell in 1937. The following year, he became resident engineer in Knoxville, Tenn., and in 1942 was appointed chief electrical engineer. During 1943-49, Mr. Ennis conducted generation and transmission system studies for rural systems, directed electrical construction for General Motors Corporation in Indianapolis, Ind., and was responsible for the electrical design of steam power plant improvements, and for hydro plant additions, transmission lines, and substations for the Alabama Electric Co-operative. Later, he prepared feasibility studies, plans, and specifications, and was placed in charge of the design and construction of the Dale Generating Station in Ford, Kentucky, and the James River Power Station in Springfield, Mo. Mr. Ennis is a member of the Missouri Society of Professional engineers in the States of Missouri, Maine, and New Hampshire.

Carl Clark Ernst (M '48), president, California Electric Power Company, San Bernardino, Calif., has been transferred to the grade of Fellow in the AIEE " . . . for contributions to the development of a rapidly expanding and changing electric power system." A native of Hulington, Ohio, Mr. Ernst was born February 12, 1897. He first became associated with the company (Calectric) in 1920 as an electrician, and later became foreman, local agent, local superintendent, and in 1927 was appointed assistant district manager of Calectric's Imperial Valley operations. In the following years, he was named, successively, manager of Calectric's Nevada Division, a vice-president, executive assistant, assistant general manager, general manager, and in 1957 was elected Calectric president and named to the company's Board of Directors. Mr. Ernst is a registered professional engineer of the State of Nevada, a trustee of the High Temperature Reactor Development Association, a member and past director of the Pacific Coast Electrical Association, and a member of the Defense Orientation Conference Association. During World War I, he served with the U. S. Army Engineers.

Charles F. Green (M '50), visiting professor in electrical engineering, Cornell University, Ithaca, N. Y., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to precise control in the field of aviation, marine and space aircraft." Born June 1, 1891, at Soldier, Kans., he received B.A. and M.A. degrees from the University of Kansas in 1914 and 1915, respectively, and the Ph.D. degree in 1920 from the University of Illinois. Dr. Green served on the retained staff of the General Electric Company as a consultant on a-c machinery and aeronautical equipment during 1925-29. He joined General Electric on a permanent basis in 1929 in the aeronautics and marine engineering department as an engineer, and later as design engineer of the department. In World War II, he was a U. S. Air Force technical representative in the European Theater of Operations. He was appointed a consulting engineer and manager of advance development in the Aeronautics and Ordnance Systems Division of General Electric in 1946. Dr. Green also became a member of the Upper Atmosphere Rocket Research Panel in 1946, and assisted the Army Ordnance Department in its operations at White Sands Proving Grounds. On retirement in 1956, he became visiting professor in electrical engineering at Cornell University and also a consultant at the Advanced Electronics Center at Ithaca. A registered professional engineer in New York, Dr. Green is a member of Sigma Xi, Phi Beta Kappa, Eta Kappa Nu, Phi Mu Epsilon, the Institute of Aeronautical Sciences, American Rocket Society, American Ordnance Association, Research Society of America, Society of Industrial and Applied Mathematics, and American Association for the Advancement of Science.

Lawrence Boyd Grew (M '36), transmission and outside plant engineer, Southern New England Telephone Company, New Haven, Conn., has been transferred to the grade of Fellow in the AIEE " . . . for contributions to communication transmission and application of radio techniques to a communication system." He was born in Brockton, Mass., on December 12, 1906, and studied electrical engineering at the Massachusetts Institute of Technology (MIT) from which he received the B.S. and M.S. degrees in 1927 and 1928, respectively. He joined the Southern New England Telephone Company in 1928 as an engineer's assistant. In following years, he was promoted to engineer, engineer of electrical co-ordination and radio, outside plant and radio engineer, and in 1952 to his present position of transmission and outside plant engineer. He is a senior

member of the Institute of Radio Engineers, and a member of the Armed Forces Communication Association. He was chairman of the New England Radio Engineers Meeting in 1953. That year, he was made an honorary member of Eta Kappa Nu at the University of Connecticut's Beta Omega Chapter, " . . . in recognition of his attainments and services in the advancement of the Science of Electricity and the Profession of Electrical Engineering . . . " In 1950, Mr. Grew was named MIT's honorary secretary-in-residence in New Haven and is now regional chairman of the MIT Educational Council for the New Haven area. Mr. Grew has served on the following AIEE Committees: Communication (1948-49), Radio Communications Systems (1951-53), and Wire Communications Systems (1955-61).

Joseph Mervyn Hambley (M '48), general manager, Hydro-Electric Power Commission of Ontario, Toronto, Ont., Canada, has been transferred to the grade of Fellow in the AIEE " . . . for contributions to the expansion of a large electric utility." Born May 26, 1905, in Copper Cliff, Ont., Canada, he was educated at Queen's University from which he received the B.S. degree in electrical engineering in 1929. Mr. Hambley joined Hydro in 1930 as an assistant engineer in the operating department and served the Georgian Bay System and Northern Ontario Properties. In 1945, he was appointed district operating engineer for the Abitibi, Sudbury, Nipissing, Timiskaming, and Manitoulin Districts. Subsequently, he was appointed, successively, director of operations for the commission, deputy assistant general manager—administration, assistant general manager—administration, and in 1960, deputy general manager. Mr. Hambley is a director of the Canadian Electrical Association, a member of the Association of Professional Engineers of Ontario, and the Electric Club of Toronto.

Harold Ray Heckendorn (AM '35, M '47), superintendent, manufacturing engineering, Western Electric Company, Columbus, Ohio, has been transferred to the grade of Fellow in the AIEE ". . . for contributions in the engineering of manufacture for the rapidly advancing communications art." He was born December 16, 1909, at Cedar Point, Kans., and studied at Kansas State University from which he received the B.S. degree in electrical engineering in 1934. In 1941, he was employed by Western Electric at the Hawthorne Works in Chicago, Ill., where he began as an engineer and progressed to the levels of department chief and assistant superintendent of manufacturing engineering. In 1955, he was staff assistant in the vice-president's office in Chicago, and later that year was promoted to superintendent of the company's Fullerton Avenue Plant in Chicago. He returned to manufacturing engineering in 1960 in the Central Office Equipment field, and in that year moved to the Columbus, Ohio, Works where he is currently superintendent of manufacturing and factory engineering. Mr. Heckendorn is a member of Sigma Tau, Phi Kappa Phi, the Western Society of Engineers, Armed Forces Communication Association, and is a registered professional engineer in the State of Illinois. His AIEE Committee activities include: Membership (1949-58, chairman 1957-58), Radio Communications Systems (1953-56), Admission and Advancement Department (1956-58), and Public Relations (1957-58).

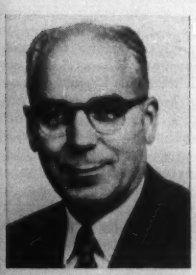
Lester Morton Ilgenfritz (M '39), member of the technical staff, transmission system development department, Bell Telephone Laboratories, Murray Hill, N. J., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the design and development of submarine cable repeaters and systems." Born October 8, 1897, in Monroe, Mich., he was educated at the University of Michigan from which he received the B.S. degree in electrical engineering in 1920. He immediately joined the development and research department of the American Telephone and Telegraph Company, and after completing the student course was assigned to transmission work in the then new field of carrier current telephony. In 1934, he transferred, along with the development and research department of American Telephone and Telegraph to the newly formed Bell Telephone Laboratories, where he continued work on new carrier systems. During the 1942-45 war years, his work was on classified problems, including underwater sound, infrared, and navigation devices. He also pioneered in the design of miniaturized carrier current terminals. Subsequently, he was directly responsible for the transmission design of the first commercial ocean bottom repeaters for submarine cables placed between Key West and Havana in 1950. During 1950-56, he was responsible for the transmission design and field lineup

L. M. Ilgenfritz

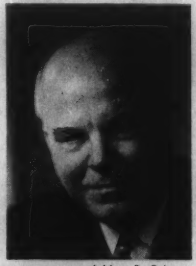
of the submarine cable system for the Atlantic Missile Range between Cape Canaveral and Puerto Rico. Mr. Ilgenfritz was responsible, in 1954-56, for the transmission design and field lineup of a new broader band submarine cable system between Ketchikan and Skagway in Alaska for the Alaska Communication System. Since 1956, he has been engaged in submarine cable system problems under Government contracts. He is a licensed professional engineer in the State of New York.

Harry Rudolph Immich (AM '33, M '42), division plant engineer, Southwestern Bell Telephone Company, Wichita, Kans., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to storm-proofing of inter-city and rural communications." Born in New York, N. Y., on June 11, 1906, he was educated at the University of Kansas from which he received the B.S. degree in electrical engineering in 1931. He became a student engineer in the plant department that year and served successively as lineman, fieldman, record engineer, and tool engineer. He transferred to Wichita as a toll engineer in 1937, and became district manager in charge of outside plant engineering in southeast Kansas in 1941. Mr. Immich was promoted to his present position of division plant engineer, Southern Division, Kansas, in 1950. A registered professional engineer in the State of Kansas, Mr. Immich is a member of Tau Beta Pi, Sigma Tau, the Kansas Engineering Society, and the National Society of Professional Engineers.

George A. Porter (M '49), vice-president in charge of engineering, construction, and operations, Detroit Edison Company,



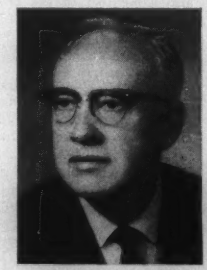
L. B. Grew



Ashley & Crippen

J. M. Hambley

H. R. Heckendorn



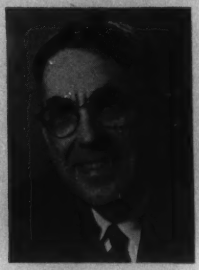
Borniger

H. R. Immich

G. A. Porter

Scobee

A. A. Road



A. L. Samuel

E. L. Sitz

Detroit, Mich., has been transferred to the grade of Fellow in the AIEE " . . . for contributions to engineering, organization and professional development in a large electric utility." Born August 15, 1902, in Nanticoke, Pa., he was educated at Cornell University from which he received the mechanical engineering degree in 1925. That year, he joined Detroit Edison in the research department. He later became, in succession, general foreman in the construction department, maintenance engineer in the production department at the Delray Power Plant, assistant superintendent of the Delray Power Plant, and personnel manager of the production department, general offices. He was also appointed personnel manager and was made a member of the Company Union Negotiation Board. Mr. Porter was subsequently appointed assistant chief engineer of power plants, chief engineer of power plants, manager of construction, and vice-president in charge of engineering, construction, and operations. In 1954, he was appointed chairman of the Detroit Sponsor Group to lead the Engineers' Council for Professional Development activity of the Professional Training Committee, whose objective is to promote the training and development of young engineers. A registered professional engineer in the State of Michigan, Mr. Porter is a Fellow of the American Society of Mechanical Engineers, and a member of the Association of Edison Illuminating Companies, Engineering Society of Detroit, Newcomen Society in North America, International Conference on Large Electric High Tension Systems, Michigan Society of Professional Engineers, Engineers' Club of New York, Tau Beta Pi, Pi Tau Sigma, Cornell Society of Engineers, and Society of American Military Engineers. He is also a member of the Board of Trustees of the Detroit Institute of Technology. He has served on the AIEE Fortescue Fellowship Committee (1958-61).

Richard Arthur Road (AM '41, M '46), vice-president, Engineering Division, Duncan Electric Company, Inc., Lafayette, Ind., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to invention, development and production of watt-hour meters." Born at Peru, Ind., August 17, 1907, Mr. Road was educated at Purdue University from which he received the B.S. degree in electrical engineering in 1929. Four years later, he joined Duncan Electric, where he has worked on many problems in the development and design of watt-hour meters and associated equipment. During World War II, he assisted in the design and manufacture of aircraft instruments and navigator training equipment. Appointed chief engineer of Duncan in 1945, he has directed the development of single-phase and polyphase watt-hour and thermal demand meters. In 1949, he was appointed vice-president and director of engineering, and in 1958 he was elected a director of the company. Mr. Road has served as chairman of the watt-hour meter technical committee and of the Test Equipment Group of the National Electrical Manufacturers Association, and is currently a member of the American Standards Association's Sectional Committee for the Code for Electricity Meters. He is a registered professional engineer in the State of Indiana, a member of the National Society of Professional Engineers, and a director-at-large of the Indiana Society of Professional Engineers. Mr. Road has served on the AIEE Indicating and Integrating Instruments Committee (1957-61).

Arthur Lee Samuel (M '34), director of research communications, International Business Machines (IBM) Research Center, Yorktown Heights, N. Y., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the development of electron discharge devices for operation in the ultrahigh-frequency range." Born December 5, 1901, in Emporia, Kans., he was educated at the Massachusetts Institute of Technology (MIT) from which he received the B.S. and M.S. degrees in electrical engineering in 1926. After 2 years as an instructor of electrical engineering at MIT, he joined the Bell Telephone Laboratories where he did research on electron tubes. During 1946-49, he was professor of electrical engineering at the University of Illinois, where he pioneered in setting up an Electron Tube Research Laboratory and helped to initiate the university's computer project. Since 1949, Mr. Samuel has been at IBM, where he has been concerned with research problems underlying the design, construction, and use of digital computers. Mr. Samuel is a Fellow of the Institute of Radio Engineers and of the American Physical Society. He is a member of the American Association for the Advancement of Science, the Association for Computing Machinery, and Sigma Xi, and is a registered professional engineer in the State of New York. He served on the AIEE Research Committee (1955-58).

Earl LeRoy Sitz (AM '32, M '47), professor of electrical engineering, Kansas State University, Manhattan, Kans., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the teaching of electrical engineering." Born in Davenport, Iowa, February 28, 1904, he received his B.S. and M.S. degrees in electrical engineering in 1927 from Iowa State University and in 1932 from Kansas State University, respectively. He was an instructor in the department of machine design at Kansas State University in 1927-28. He transferred to the department of electrical engineering as an instructor in electrical engineering in 1928, and for the next 20 years was, successively, instructor, assistant professor, and associate professor in that department. Since 1948, he has been professor of electrical engineering. For the years 1940-41 and 1945-46, he was granted leave of absence to work for the Westinghouse Electric Corporation in the motor engineering department as a design engineer. In 1948, he spent the Winter and Spring quarters teaching in the electrical engineering department at the Michigan College of Mining and Technology. He is co-author of a book, "Basic Theory in Electrical Engineering." A licensed engineer in the State of Kansas, Mr. Sitz is a member of Eta Kappa Nu, Sigma Tau, Phi Kappa Phi, and the American Society for Engineering Education. He is a past chairman of the Kansas City Section, AIEE, and has served on the AIEE Student Branches Committee (1954-55).

Joseph A. Strelzoff (AM '43, M '44), professor, engineering department, Michigan State University, East Lansing, Mich., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the engineering education and the teaching of Electromagnetic Theory." He was born June 21, 1899, in Krememtchoug, Poltava, Russia, and studied at the University of Liege in Belgium from which he received mechanical and electrical engineering degrees in 1923 and 1925, respectively. He continued his studies at Cornell University, from which he received the master's degree in electrical engineering in 1932 and the Ph.D. degree in 1934. He worked as an engineer for 4 years in Belgium and 3 years in the United States, where he was employed first by Stone and Webster of Boston,

J. A. Strelzoff

G. F. Tracy

T. W. Trice

H. J. White

Mass., and next for the Pennsylvania Power and Light Company in Allentown, Pa. Since 1942, he has been a professor in the electrical engineering department at Michigan State University. Since 1948, he has been employed as a consultant for Consumer's Power Company in Jackson, Mich., and during 1957-61 as a consultant with the Radio Corporation of America. He is a senior member of the Institute of Radio Engineers and a member of Sigma Xi, Tau Beta Pi, Eta Kappa Nu, and Phi Kappa Phi. Dr. Strelzoff has served on the AIEE Transmission and Distribution Committee (1954-61) and Basic Sciences Committee (1954-61).

Gordon Frederick Tracy (AM '26, M '46), professor and head of the electrical engineering department, University of Toronto, Toronto, Ont., Canada, has been transferred to the grade of Fellow in the AIEE ". . . for contributions to electrical engineering education." He was born February 2, 1896, in Toronto. In 1921, he received the B.A.Sc. degree in electrical engineering from the Faculty of Applied Science of the University of Toronto, and in 1926, the M.S. degree in electrical engineering from the Massachusetts Institute of Technology. He was a research assistant in the department of electrical engineering of the University of Toronto during 1921-24. The following year, he became an instructor in the electrical engineering department of the University of Wisconsin, and rose to assistant professor, associate professor, and professor, successively. Since 1947, he has been professor and head of the electrical engineering department, University of Toronto. A registered engineer in the Province of Ontario, he is a member of the American Society for Engineering Education, Tau Beta Pi, and the Royal Canadian Institute. Mr. Tracy has served as vice-president of AIEE District 10 (1957-59) and on the following AIEE Committees: Education (1948-57), and Periodicals and Transactions (1959-60).

Thomas Wheeler Trice (AM '36, M '49), vice-president—Electric Operations, Baltimore Gas and Electric Company, Baltimore, Md., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the management of engineering and operations of a major electric utility system." Born July 23, 1904, in Oak Grove, Del., he received his B.S. degree in electrical engineering in 1928 from the Carnegie Institute of Technology. In 1936, Mr. Trice became associated with the Consolidated Gas Electric Light and Power Company of Baltimore, Md., now the Baltimore Gas and Electric Company, as a testman in the electric test department. He advanced to the occupation of technical assistant engineer, and in 1939 was appointed assistant electrical engineer. Subsequently, Mr. Trice became general superintendent—Electric Operations, and in 1960 was elected vice-president—Electric Operations. A registered professional engineer in the State of Maryland, he is a member of the American Society of Mechanical Engineers, National Society of Professional Engineers, Maryland Society of Professional Engineers, American Meteorological Society, Maryland Academy of Science, American Ordnance Association, and Theta Tau. Mr. Trice has served on the AIEE Rotating Machinery Committee (1947-49).

Harry James White (M '49), executive officer, applied science department, Portland State College, Portland, Ore., and scientific consultant, has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the theory of practice of electrostatic precipitation." He was born July 29, 1905, in Fremont, Nebr., and received the B.S. degree in electrical engineering in 1928 and the Ph.D. degree in physics in 1933, both from the University of California. He was associated with the Research Corporation, Bound Creek, N. J., during 1935-41, engaged in basic research work in electrical precipitation. In 1941, he was a staff member in the Office of Scientific Research and Development, Radiation Laboratory, Massachusetts Institute of Technology. He returned to Research Corporation in 1945 as director of research. In 1958, he became director of research and development for Research-Cottrell, Inc., and in 1959 was made a member of the Board of Directors of Research-Cottrell, a position he still retains. Since 1960, he has had administrative responsibility for a new program in applied science at Portland State College. He has participated as advisor and senior lecturer in the Summer seminars on electrostatic precipitation conducted by the electrical engineering department of Pennsylvania State University for the last 8 years. He is a Fellow of the American Physical Society, a member of Sigma Xi and of the American Society of Engineering Education, American Association of Physics Teachers, American Association of University Professors, and American Geophysical Union. He has served on the AIEE Electronics Committee (1952-59).

AIEE PERSONALITIES

A. C. Abbott (M '46), formerly vice-president, Shawinigan Water and Power Company, Montreal, Que., Canada, has been named executive vice-president and elected to the Board of Directors. **W. R. Way** (M '42, F '53), formerly vice-president, has been appointed senior vice-president.

S. J. Angello (AM '42, M '51), project manager in the new products laboratories of Westinghouse Electric Corporation, has been named Visiting Mackay Professor of electrical engineering at the University of California. Dr. Angello will present a special series of lectures in the field of semiconductors at the university's department of electrical engineering. Dr. Angello has served on the AIEE Solid State Devices Committee (1955-61, chairman 1957-59) and Science and Electronics Division Committee (1957-61).

A. A. Baechle (AM '57) has been named acting executive vice-president of the Electrical Apparatus Service Association, Inc. Mr. Baechle joined the association's St. Louis headquarters' engineering staff last September 1.

E. C. Barnes (AM '41, M '48), chief engineer, Reliance Electric and Engineering Company, has been elected second vice-president of the Cleveland Engineering Society, Cleveland, Ohio. He has served on the AIEE Rotating Machinery Committee (1955-61).

W. C. Beattie (AM '52), formerly assistant vice-president of the Consolidated Edison Company of New York, Inc., has been elected vice-president.

N. A. Begovich (AM '44), assistant manager of Hughes Aircraft Company's

ground systems group in Fullerton, Calif., and director of product line operations there, has been appointed a vice-president of the company. Dr. Begovich is responsible for the development of 3-dimensional radar at the company. He conceived the idea of radar scanning by electronic means rather than mechanical and later invented a family of "3-D" radars manufactured by Hughes and now in service in the armed forces.

G. S. Brown (AM '33, F '50) has been elected to the Board of Directors of the Gorham Manufacturing Company. Dr. Brown is currently the dean of engineering at the Massachusetts Institute of Technology. He has served on the AIEE Education Committee (1958-61).

P. M. Burgess (AM '54) has been appointed by the Special Systems Division of Minneapolis-Honeywell Regulator Company as a specialist in load and frequency control systems. Mr. Burgess joined Honeywell in 1959 as a system engineer, and was transferred to the Special Systems Division at Pottstown, Pa., when this unit was formed in 1960.

S. R. Chapman (AM '54) has been named assistant sales manager, aluminum products, for Rea Magnet Wire Company, Inc., subsidiary of Aluminum Company of America (Alcoa). Mr. Chapman formerly served as manager of the Electrical Section of Alcoa's Sales Development Division at New Kensington, Pa.

E. A. Christian, Jr. (AM '57) has been named chief engineer of the Sequoia Wire and Cable Company, a subsidiary of the Anaconda Wire and Cable Company. He joined Anaconda in 1956 as a cable engineer.

W. L. Cisler (M '35, F '47), president and director of the Detroit Edison Company, Detroit, Mich., has been elected president of the Society of American Military Engineers. Col. Cisler has served on the AIEE Edison Medal Committee (1956-61).

C. P. Clare (M '34, F '52), executive vice-president, has been named chief executive officer of Universal Controls, Chicago, Ill. An engineer in the field of relays and related control systems, Mr. Clare is a director of Universal Controls and president of C. P. Clare & Co., a Universal Controls company.

G. L. Curtis (M '59) and **B. R. Stack** (M '56) have been promoted to associate laboratory directors at the Federal Laboratories of International Telephone and Telegraph Corporation (ITT), Palo Alto, Calif. Mr. Curtis will be in charge of the multiplexing laboratory and Mr. Stack will head the communication laboratory at the West Coast location. Both Mr. Curtis and Mr. Stack were formerly executive engineers. **W. S. Chaskin** (AM '55), who formerly headed the Palo Alto operation, has been appointed manager of engineering at the ITT Kellogg carrier and microwave equipment manufacturing plant, Raleigh, N. C. Mr. Stack has served on the AIEE Wire Communications Systems Committee (1956-61).

R. D. Cutkosky (AM '60), a physicist in the Resistance and Reactance Section of the National Bureau of Standards (NBS), has been awarded the U. S. Department of Commerce Silver Medal for Meritorious Service. He was cited for "very valuable contributions in the field of electrical measurements and standardization." Mr. Cutkosky joined the Bureau in 1955 and for 2 years assisted in the evaluation of the NBS unit of electrical current. Since that time, he has been concerned with the improvement of methods for measuring electrical quantities.

H. V. Diamond, Jr. (AFFIL '53) has been made production manager of residential equipment of BullDog Electric Products division of I-T-E Circuit Breaker Company, Detroit, Mich. Mr. Diamond joined BullDog in 1951.

Leo Dolkart (M '46, F '58, Member for Life) has been elected to the Advisory Council of the Society for the History of Technology. He has served on the AIEE Industrial and Commercial Power Systems Committee (1949-61).

G. R. Dunbar (AM '49, M '55) has been named manager of aviation industry sales for the Westinghouse Electric Corporation, Pittsburgh, Pa. He is responsible for co-ordinating sales of Westinghouse products to the aviation industry. Mr. Dunbar was formerly manager of aviation and electronic facilities at Westinghouse in Los Angeles, Calif., in 1959.

E. P. Dunlaevy (AM '41), executive vice-president of Phelps Dodge Copper Products Corporation, has been re-elected as senior vice-president of the Copper and Brass Research Association.

G. A. Dusch (AM '51) has been named director of the Market Research and Product Planning Department, Cornell-Dubilier Electronics Division of Federal Pacific Electric Company, Newark, N. J.

H. C. Dusek (AM '59) has been named assistant engineer in the thermal power department of Allis-Chalmers Manufacturing Company, Milwaukee, Wis. He has been assigned to the insulation group of the Allis-Chalmers General Design Section in the department.

E. P. Eaton, Jr. (AM '46), president, Carbone Corporation, Boonton, N. J., has been elected chairman of the newly formed Static Conversion Section of the National Electrical Manufacturers Association. **K. M. Patterson** (AM '49), manager, headquarter sales, Westinghouse Electric Corporation, East Pittsburgh, Pa., has been elected vice-chairman of the Section.

E. A. Edwards (AM '39, M '49), assistant director of the engineering division at the Kodak Park Works of Eastman Kodak Company, has been named assistant director of the film services division.

J. A. Elzi (AM '37, F '48), **M. C. Westrate** (AM '37, F '58), and **C. E. Asbury** (AM '39, M '46) have been elected vice-presidents of Commonwealth Associates Inc., New York, N. Y. Mr. Elzi will continue to serve as director of engineering administration, and Mr. Westrate as treasurer and chief consulting engineer. Mr. Asbury continues his duties as chief electrical design engineer. Mr. Asbury has served on the AIEE Switchgear Committee (1952-61) and Standards Committee (1959-61).

N. H. Enenstein, formerly director of the Data Systems Laboratory of Litton Systems, Inc., at Canoga Park, Calif., has been promoted to director of technical administration.

C. F. Ffolliott (M '38, F '50), director, Product Design, Automatic Electric Laboratories, Inc., has been appointed technical director of Automatic Electric International, Inc., at Geneva, Switzerland. He succeeds **Imre Molnar** (M '53), who is returning to the United States. **G. A. Borling** (AM '49), formerly supervisor of relay and switch design, has become supervisor, electromechanical design. Mr. Ffolliott and Dr. Molnar have served on the AIEE Communication Switching Systems Committee (1955-61) and (1960-61), respectively.

S. K. Fosholt (AM '39, M '45), a partner and operations manager of Stanley Engineering Company of Muscatine, Iowa, has been named second vice-president of the Consulting Engineers Council.

R. J. Gilson (AM '50) has been appointed general manager of the Military Products Division—Rochester, N. Y., of General Dynamics/Electronics. Mr. Gilson was formerly director of systems management for the division.

D. J. Goodman (AM '48, M '55), assistant chief, and **D. A. Roberson** (AM '44, M '51), assistant branch manager, Electrical Branch, both of the Technical Services Division, Aro, Inc., Arnold Air Force Station, Tenn., have been elected state president and state secretary, respectively, of the Tennessee Society of Professional Engineers for the current year. Mr. Goodman has served on the AIEE Registration of Engineers Committee (1960-61).

R. M. Grogan (M '46) has been elected vice-president in charge of the Office of Production, Transmission and Construction, Long Island Lighting Company, Mineola, L. I., N. Y. He was formerly manager of the Office of Production, Transmission and Construction.

Raymond Guy (M '57, F '59), American aid advisor now in Viet-Nam to assist in the establishment of a national radio network, has been awarded a distinguished service award by the National Association of Broadcasters for his service to his profession, the industry, and the nation. Mr. Guy is credited with the longest continuous service as a full-time broadcast engineer in the world. Before going to Viet-Nam, he was a consultant in Haworth, N. J., and served the Radio Corporation of America and the National Broadcasting Company for almost 40 years. He entered broadcasting in New York in 1921 as engineering-announcer for the old WJZ. He directed National Broadcasting's FM field

tests in 1939-40 and UHF TV tests at Bridgeport, Conn., in 1951-53, and has been active in allocations of frequencies. He served on the AIEE Broadcasting Committee (1956-61).

OBITUARIES

Frank Gardner Beetem (AM '09, M '42, Member for Life), retired engineer of the Electric Storage Battery Company, Philadelphia, Pa., died May 19 at the age of 78. Mr. Beetem was born November 17, 1882, in Carlisle, Pa. In 1905, he was employed by the company and was assigned to the electrification of the New York Central Terminal and the split pole rotary converter-storage battery regulating system installed at the Gary Steel Works. Subsequently, he was transferred to the electrical engineering department of the company in Philadelphia. During World War I, he served as a civilian employee in the Radio Development Section of the Signal Corps in Washington, D. C., and in World War II he assisted in the development of battery propelled torpedoes for the U. S. Navy. Mr. Beetem retired from the company in 1945.

Robert Leslie Chapman (AM '24, M '30, Member for Life), application engineer, General Electric Company, Erie, Pa., died recently. Mr. Chapman had been associated with General Electric since 1922, in locomotive design for about 30 years and later in marketing and product planning. He was born December 30, 1896, in New Lancaster, Kans. Mr. Chapman was a licensed engineer in the State of Pennsylvania.

Robert B. Gear (AM '30, M '37, F '55), director of purchases, Commonwealth Edison Company, Chicago, Ill., died recently. Born October 16, 1904, in Chicago, Ill., he was educated at Cornell University from which he graduated in 1928 with the B.S. degree in electrical engineering. Mr. Gear joined Commonwealth Edison in 1928 as a Central Station Institute student. The following year, he became a line extension estimator in the Distribution Division of the engineering department, a position he held until 1932, when he was promoted to assistant engineer in the Station Installation Division of the engineering department. In 1933, he became assistant field engineer responsible for 4,000-volt transformer vault work throughout the city as well as network vault development work. In 1933-34, he developed an underground network vault design, and in 1936, was named field engineer, assigned to generating station work. During World War II, he was responsible for the preparation of engineering plans and logistical operations for which he was awarded an Army Commendation Medal. Released from active duty in 1945, he returned to Commonwealth Edison as senior engineer in the Station Design Division. In 1950, he was promoted to section engineer and placed in charge of electrical design for all generating and distributing stations. In 1952, he became project manager in

R. B. Gear

charge of development of nuclear power plant design. In 1953, he was named purchasing director in charge of purchasing all mechanical equipment, including turbogenerators, steam generators, and station and substation construction. A registered engineer in the State of Illinois, Mr. Gear was chairman of the Public Utility Buyers Group of the National Association of Purchasing Agents (1960-61) and chairman of the Edison Electric Institute Purchasing and Stores Committee (1960-61). Mr. Gear has served as AIEE District 5 vice-president (1958-60) and Director-at-Large (1960-64). He was a member of the following AIEE Committees: Marston Medal Board of Award (1956-64), Board of Directors (1958-64), Executive Committee (1960-61), and Planning and Co-ordination (1960-61).

Will G. Kelley (AM '08, M '21, F '26, Member for Life), assistant chief electrical engineer of the Chicago Edison Company, Chicago, Ill., until his retirement on January 31, 1948, died recently at the age of 82. Born February 8, 1879, in Burlington, Iowa, he was educated at the Massachusetts Institute of Technology from which he graduated in 1901 with the B.S. degree in electrical engineering. Mr. Kelley started his utility career the same year as an inspector of electrical wiring with Chicago Edison. He subsequently became assistant district engineer, overhead engineer, assistant engineer of distribution, and plant design engineer. In 1943, he was named assistant chief electrical engineer. Mr. Kelley was a member of the American Society for Testing Materials, National Electric Light Association, American Standards Association, International Electrotechnical Commission, and International Conference on Large Electric High Tension Systems. At the time of his retirement, he was vice-chairman of the Utilities Research Commission and a director of the Electric Association. He served on the AIEE Power Transmission and Distribution Committee (1924-25).

Chester Henry Lang (AM '43), retired vice-president for public relations of the General Electric Company, Schenectady, N. Y., died June 15 at the age of 68. He was born January 12, 1893, in Erie, Pa. He received the B.A. degree from the University of Michigan in 1915 and served overseas in World War I as a lieutenant with the 129th Field Artillery, 35th Division. Mr. Lang joined General Electric as a traveling auditor in 1919. Three years later, he became assistant director of the publicity department, and in 1926, controller of the budget. In 1932, when he was made manager of advertising and sales promotion, he flew over Schenectady in the dirigible *Los Angeles* to mark the opening of General Electric's radio station WGY. Mr. Lang became manager of apparatus sales in 1940 and a vice-president the next year. During World War II, he was chairman of General Electric's war projects committee. He returned to publicity in 1951 when he was placed in charge of the concern's public relations division. During 1952-55, he co-ordinated the "Engineers Wanted" campaign of the Advertising Council.

Phillip Morgan McCullough (M '51), consulting engineer in Central America, the United States, and Mexico, died May 28. He was vice-president of Automatic Electric International, Inc., a subsidiary of General Telephone and Electronics Corporation, until his retirement in 1958. Born October 31, 1893, in Omaha, Nebr., he began a career in communication engineering and management in 1908 with the Omaha Telephone Company. In 1917, he graduated from the University of Nebraska with the B.S. degree in electrical engineering. During World War I, he served in the U. S. Army Signal Corps as a captain, and after the war resumed his career in Omaha as a division engineer. Mr. McCullough went to Mexico in 1925 as chief engineer of the Mexican Telephone and Telegraph Company, and in 1929 he was named vice-president and general manager. In 1934, he became consulting engineer in New York City for Associated Telephone Utilities, General Telephone, and Postal Telegraph and Cable Corporation. At the outset of World War II, Mr. McCullough helped organize the field service of the War Production Board, and later became chief of the communications division of the U. S. Commercial Corporation, concerned with highly critical war communications activities. He joined Automatic Electric International in 1944 as vice-president, and served as a key executive, planning and managing a wide range of sales projects in Europe, the Far East, and Latin America.

William Welch, Jr. (M '53), vice-president of the Long Island Lighting Company, Mineola, L. I., N. Y., died June 23 at the age of 56. A native of Camden, N. J., where he was born December 18, 1904, he was a graduate of the Stevens Institute of Technology from which he received a degree in mechanical engineering. Mr. Welch joined the company in 1941, and held the positions of steam power engineer, assistant mechanical engineer, and assistant gas operating manager, in succession. In 1950, he was named assistant vice-president and engineering manager, and in 1958, vice-president in charge of engineering, purchasing, and stores. Mr. Welch was a member of the American Gas Association, Edison Electric Institute, and Long Island Association. He also belonged to the American Society of Mechanical Engineers, Society of Corrosion Engineers, American Institute of Chemical Engineers, American Standards Association, and was an honorary member of Pi Tau Sigma.

OF CURRENT INTEREST

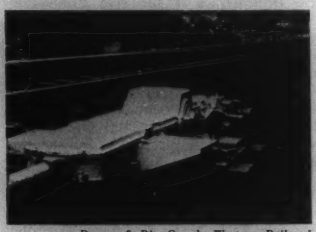
Centralized traffic control installations give train dispatchers control over signals and switches 100 miles away for efficient traffic handling

New York Central Railroad

Centralized Traffic Control Shows Important Railroad Operating Savings

Since the introduction of centralized traffic control (CTC) on a 40-mile stretch of track between Berwick and Toledo, Ohio, some 34 years ago, this system of remote control has expanded to include more than 34,000 miles of heavily traveled track throughout the nation. Since World War II alone, mileage of track covered by CTC has expanded fivefold.

One of the great advantages of CTC is the fact that it increases the capacity of a single-track line by 75% to 80%, frequently making double-tracking unnecessary. The system enables trains moving toward each other on the same track to "meet" and pass each other without stopping, by moving the "inferior" train off the main line onto a passing track.



Denver & Rio Grande Western Railroad

Power switch and signal shown are integral parts of a centralized traffic control installation between Kobe and Avon, Colorado

With all its electronic intricacy, CTC nevertheless involves a relatively simple operation. A train dispatcher, seated before a control board, watches a series of blinking and shifting lights that represent trains moving over tracks traced on a large diagram mounted on a panel in front of him. Below the lights are a number of levers which control switches and signal lights on tracks within the territory monitored by the CTC system.

As lights move into proper position, the dispatcher throws a lever and, miles away, one of the trains turns onto a passing track while another continues on its way. Then, when the main line is cleared, the train on the passing track gets the green light and moves toward its destination.

CTC also contains a built-in, foolproof safety feature. Controls are so interlocked that it is impossible to set up a conflict in train movements. Neither switches nor signals respond to conflicting routes.

Train and engine crews move their trains in accordance with signals displayed. On a single 19-mile stretch of railroad, for example, CTC has made it possible to save 5,500 train-hours a year. About a minute a mile each has been chopped off the schedules of 50 trains operating each day.

Officials of one western railroad have estimated that CTC will result in nearly 11,000 fewer train stops on their line. And a 33-mile CTC installation in Texas has meant a saving of more than 3,000 freight-car days annually.

Other important operating savings for railroads have been made possible by CTC. For instance, on a 238-mile installation in Nebraska, costing approximately $1,680,000, a railroad realized a net annual saving of more than $240,000—a return of almost 15% on capital invested.

Another railroad, faced with the necessity of renewing rail on a 67-mile stretch of double track, decided instead to install CTC on the usable track and to eliminate the old one. The company realized a net saving of almost $1 million. Moreover, the road is realizing savings in annual operating expenses of more than $100,000 from CTC.

During the past three decades, and more particularly in the last 15 years, CTC has proved to be a valuable adjunct to the railroads' modern system of traffic control. As such, it has ranked high on the list of signaling improvements made possible by the industry's $16 billion postwar modernization program. And for travelers and shippers who rely on railroads, the net result has been smoother-functioning railroads operating with greater efficiency, faster schedules, and increased train loads.

New Superconductor Developed by AEC Contractor

A new superconductor material which offers no resistance to appreciable quantities of electric current has been developed by Atomics International, a division of North American Aviation, Inc., under a research contract with the Atomic Energy Commission (AEC). Atomics International (AI) is located at Canoga Park, Calif.

A wire which can be easily coiled has been drawn from the new superconductor. At liquid helium temperatures (—452 F) the wire has conducted 100,000 amperes of electric current per square centimeter in a moderately high magnetic field (30,000-gauss). The performance of this wire may be roughly equated with operation of a household electric appliance at about 100,000 watts from a normal-size (110-volt) wall outlet.

The new material is a cold-worked alloy made up of approximately three parts of niobium to one part of zirconium. The alloy is malleable and strong and can be made into wires, bars, strips, and other shapes without losing its superconducting properties. It is expected to retain these characteristics in substantially higher magnetic fields. Its development makes possible the fabrication of superconductor magnets to replace conventional bulky and relatively inefficient iron-core electro-

magnets. The superconductor magnet has no iron core and may produce magnetic fields many times higher than conventional electromagnets in common application today.

The scientists who developed and tested the characteristics of the new niobium-zirconium alloy are T. G. Berlincourt, R. R. Hake, and D. H. Leslie, of Atomics International. The Chase Copper and Brass Company of Waterbury, Conn., drew the niobium-zirconium wire used in the AI tests.

Potentially, the use of superconducting magnets of 100,000-gauss strength for high-energy particle accelerators, or in connection with controlled thermonuclear research devices, could reduce their cost of operation. Similarly, superconducting magnets may be particularly important in space technology where lightweight magnets are needed. Such magnets could store more electric energy in less space than conventional electric capacitors.

Visual Glide Slope Indicator System Installed at La Guardia Airport

An aerial landing traffic light system designed to help an approaching plane stay on the exact glide path to the runway has been installed at La Guardia Airport by Sylvania Electric Products Inc., a subsidiary of General Telephone & Electronics Corporation. The visual glide slope indicator (VGSI) guides the pilot to the landing end of the runway, helps to prevent "undershooting" or "overshooting" this area, and to assure utilization of the runway's full length.

The system of lights is designed to enhance safety at airports by providing pilots with an easy-to-read visual means of following a predetermined glide path on final approach to the runway. It can be used by all types of aircraft without additional equipment in the cockpit, making it equally beneficial to large commercial planes, and to the smaller aircraft that comprise the general aircraft fleet.

VGSI Complement

The Sylvania electronic flashing approach system (EFAS), already in wide use, provides long-range directional guidance to the pilot during periods of low visibility, when he is approaching the airport and before he begins his final descent. The VGSI system, used at night and in the daytime, in all weather, provides guidance in the final descent to the runway.

The VGSI uses four banks of lights, two banks on either side of the runway, all placed at right angles to the runway. Two banks are located 500 feet and the other two 1,000 feet or more in from the landing end of the runway. Each bank contains nine white lamps, each lamp partially hooded with a red lens. When a plane is coming in too low, the pilot sees only red light; when the approach is too high, he sees only white. When, however, the aircraft is on the correct approach slope, the pilot sees white light from the two nearer banks, and red from the two farther banks.

A properly calibrated VGSI system is effective down to about 35 feet above the ground and 600 feet horizontally from the proper point of landing. The system is visible as far as 15 miles at night and 5 miles in daylight.

Slight Deviation Shows Pink

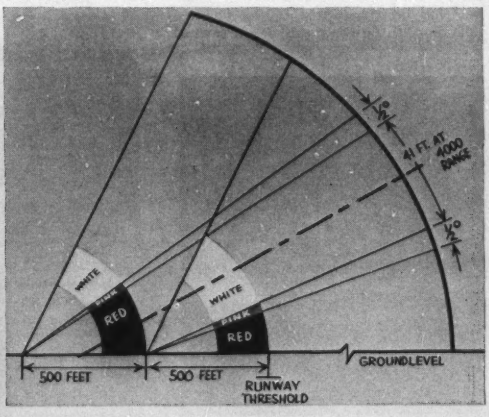
The VGSI system, in addition to showing all-white or all-red lights when the plane is too far off the glide slope, shows pinkish hues when the deviation is only slight. The pilot sees a pink-white effect when the approach is slightly high, and red-pink when it is slightly low.

A bank of lights consists of three metal boxes each containing three PAR 64, 200-watt sealed beam lamps, each of which is fitted with a red lens over approximately two thirds of its surface. The light beams pass through a horizontal slit at the front of the box to provide the proper beam distribution and color "cut-off." The intensity of the light may be controlled from the airport tower.

The system has been approved by the FAA and adopted as a world standard by the Council of the International Civil Aviation Organization. Unless a majority of the 86 member nations of ICAO disapprove, the standard will be come effective on October 1.

The VGSI system originally was developed by the Royal Aircraft Establishment, the English counterpart of the FAA, and Thorn Electrical Industries Ltd., of England, a Sylvania affiliate. The equipment produced by Sylvania is manufactured at the Lighting Products Division's plant at Ipswich, Mass.

The first commercial airport installation of an aerial landing traffic light system designed to help an approaching plane stay on the exact glide path to the runway. Two banks of lights are on either side of the runway; all at right angles to it. Two banks are located 500 feet in from the landing end of the runway, and the other two 1,000 feet or more in. Each has nine white lamps partially hooded with red lens



Engineer's sketch describes the operation of VGSI (vertical scale exaggerated). When the plane is coming in too low, the pilot sees only red light from two sets of banks that flank the runway; when the approach is too high, he sees only white light. When the aircraft is on the correct approach slope, the pilot sees white light from the nearer banks, and red light from the farther banks

USAS American Mariner carries $30,000,000 worth of test equipment for taking measurements and readings of nosecones and other parts of intermediate and intercontinental ballistic missiles fired from Cape Canaveral. Radar and optical and infrared techniques are used

Floating Laboratory Gathers Re-Entry Data

Cruising in the Caribbean and South Atlantic, the highly instrumented U. S. Army Ship *American Mariner* takes measurements of missiles fired down the Atlantic Missile Range from Cape Canaveral, Fla. The data are reduced by advanced computers into information useful in missile research.

The ship operates as part of DAMP, the Downrange Antimissile Measurement Program. This program has been established, under the joint sponsorship of the Army Rocket and Guided Missile Agency (ARGMA) and the Advanced Research Projects Agency (ARPA), for the purpose of investigating the physical characteristics of ballistic missiles as they re-enter the earth's atmosphere. The *American Mariner* has been converted into a floating laboratory to facilitate this measurements program. The ship carries high-performance tracking radars, optical instruments, darkroom facilities, and electronic operation and maintenance facilities.

The Radio Corporation of America and Barnes Engineering Company are both prime contractors in Project DAMP. Operating under a contract with ARGMA, RCA manages ship operations and has responsibility for radar equipment and associated recording devices. Barnes Engineering Company also tracks re-entry bodies, using optical and infrared instruments. Detailed photographic coverage is also provided.

By using the vast array of electronic equipment aboard the ship, operators are able to sight in on missile parts as they fall from the upper atmosphere and record physical characteristics of the re-entry. Particle trails are emitted by the missile fragments and nosecone as they fall to water. The trail of particles, ionization effect, and other physical phenomena are of significant interest in various spheres of research in missile design and missile defense systems.

Ballistic camera arrays remain stationary during a test. Re-entry objects streak through their fields of view. Solenoid-driven shutters open and partially close for alternate half seconds, permitting target velocity determination of bright and dim re-entry objects

Automatic infrared tracker is pointed at target. Once target is in the field of view, automatic tracking signals are produced

Transit navigation system aboard the American Mariner makes precise radar measurements of orbiting satellites. Technique allows ship to compute its own position with high accuracy

Radar Equipment

Tracking aboard the *American Mariner* is performed with two *AN/FPQ-4* radars and a *UHF/L*-band radar.

The *UHF/L*-band radar weighs more than 57 tons. It transmits signals on two frequency bands simultaneously. The base of the radar is a 12-foot-high Navy gun mount which formerly mounted two 5-inch guns on a destroyer. On top of the mount are the radar's 28-foot saucer-shaped antenna and servo drive.

Associated equipment for the huge radar is housed in a van mounted above decks near the pedestal. Data processed by this radar and the two *AN/FPQ-4* radars are stored by special high-speed recording equipment. These data are flown

Radiation measuring equipment aboard each pedestal is checked before a mission. Technician is shown loading the boresight camera as part of the routine check

to the DAMP data reduction center at RCA's Moorestown, N. J., plant and then distributed to various government and scientific agencies.

Optical Instruments

Optical measurements made aboard the ship cover the spectral region from the far infrared through the ultraviolet, within the spectral limits imposed by the atmosphere. Barnes Engineering Company has installed a number of optical measuring instruments, support equipment for these instruments, and a data-recording and preliminary reduction facility. In addition, a data-reduction and analysis facility is maintained at the company's laboratory in Stamford, Conn.

Measurements must be made over a wide range of intensities, spectral regions, and fields of view. As a result, a number of specialized instruments are required.

A dual array of spectral ballistic cameras has been designed to provide a wide field of view and a spectral record of the re-entry phenomena as a function of both range time and spatial orientation. Spectral sequence cameras permit an instant-by-instant record of the spectra of the re-entering bodies throughout the ultraviolet, visible, and near infrared. These use transmission gratings and 70-mm sequence action cameras having moderately large fields of view.

A 4-channel photometer provides absolute calibration values of radiation at several appropriately placed points in the spectra shown by the photographic recording instruments. Each channel of the photometer uses a multiplier phototube equipped with a filter passing the narrow regions of the spectrum that are of special interest.

Measurements in the intermediate and far infrared are provided by a number of Barnes radiometers. The radiometer is a wide-angle instrument designed for rapid interchange of detector packages and chopper packages. During daylight measurements and quite often during nighttime measurements, the instrument is used with its space-filtering reticle which provides excellent background discrimination.

To provide accurate information on the make-up of the re-entry complex, a high resolution, 70-mm cine camera has been provided. This instrument makes use of a 40-inch lens and 70-mm film to provide high quality, high magnification motion-picture records of the re-entry bodies.

Data-recording equipment, timing units, audio tape recorders, and control switches are located almost directly below the slave pedestals on the port side of the ship. Some checkout, repair and electronic calibration facilities are maintained at this location as well.

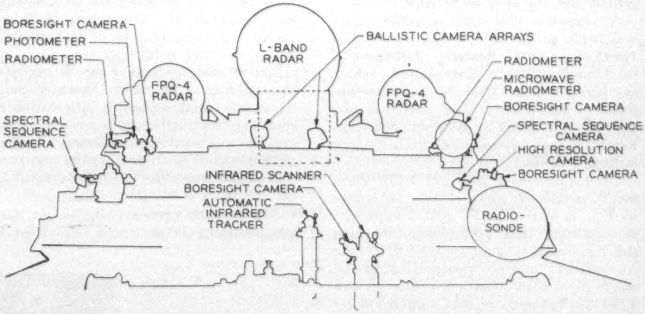
Wide-field radiometric measurements are conducted in the near infrared with a multielement scanner. Fifty lead-sulfide cells scan a 3- by 10-degree area of sky and measure the relative position and intensities of all targets within the field of view to an angular precision of one milliradian.

Infrared Tracker

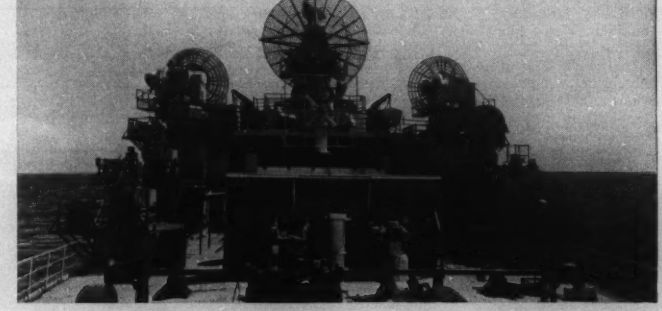
An automatic infrared tracker is used to track re-entering missiles. This tracker requires no transmitter or source other than the missile itself. Operation is based upon the fact that the re-entering missile emits infrared radiation, which the tracker receives and converts into electric tracking signals.

A joystick is used to point the tracker at the re-entering missile. Once the target is in the instrument's field of view, no further action is required by the operator. The tracker provides electrical tracking signals which can be used to keep it and auxiliary measuring instruments pointed at the target.

The tracker system consists of an optical head mounted on a servo-driven pedestal, a control unit, and a power supply and servo amplifier unit. In the optical head is a mirror system for collecting and focusing infrared target radiation, an infrared detector for converting this radiation to the form of an electrical signal and a preamplifier for raising the



Outline drawing reproduced above shows positions of electronic equipment as viewed from stern of the American Mariner. Illustration below shows the actual physical appearance of these same pieces of equipment



electrical detector signal to a level suitable for further processing. Also contained in the optical head is a rotating reticle of clear and opaque spokes. The reticle modulates the radiation before it reaches the detector and encodes this radiation so that it contains information concerning the position of the target.

Because of the encoding action of the reticle, the detector output is an FM signal which contains radial and angular target position information in polar-coordinate form. The electronic system which follows further amplifies this signal, limits its amplitude, discriminates the FM signal and changes the polar-coordinate information to the form of elevation and azimuth error signals. These final error signals can then be used to drive the servo pedestal on which the tracker is mounted to keep the tracker automatically pointed at the target.

AUTOPROMT, New Advance in Numerical Control Factory Production

A powerful new computer language, designed to broaden the use of numerically controlled machine tools for automated production of complex parts, was demonstrated recently by International Business Machines Corporation (IBM). The AUTOPROMT program is the first that enables the user to describe the surfaces of the 3-dimensional shape to be milled, rather than each path the tool must follow to machine the part. AUTOPROMT leaves to a computer the task of automatically generating these tool paths on the basis of a simple description, in English-like terms, of the part to be milled and the tool to be used.

A complex helicopter gearbox cover was made earlier this month at the East Hartford, Conn., Research Laboratories of United Aircraft Corporation, which co-operated with IBM in the development of AUTOPROMT. The part was machined on a Pratt & Whitney Numeric-Keller, a tape-controlled continuous-path milling machine.

From a blueprint, only 180 1-line statements in the AUTOPROMT language were written to describe the part completely. A solid-state IBM *7090* computer—using this information and controlled by the AUTOPROMT master program—generated more than 8,000 tool path instructions. They spelled out to the Numeric-Keller every tool motion required to machine the part.

The computer's instructions, converted to perforated tape for use by the machine tool, enabled the milling job to be completed in about one fourth the machining time previously required to mill the same part with conventional methods. The saving in lead time is even greater. To produce this part by conventional methods required 3 months from blueprint to production. With AUTOPROMT, any part of similar complexity can be put into production in 2 weeks, one sixth the lead time normally required.

AUTOPROMT (Automatic programming of machine tools) is the product of 25 man-years of development effort. It was written for IBM *704*, *709*, and *7090* computers. Its wide application is expected in aircraft, missile, and automotive manufacturing and throughout the metalworking industry. Small machine shops will be able to employ AUTOPROMT by using computers available at facilities such as IBM Datacenters.

AUTOPROMT's ability to program complex 3-dimensional shapes is expected to offer engineers new freedom in realizing the original design intent of a product, in both mechanical function and appearance. It should free designers from compromising their efforts in order to avoid expensive hand-tooling or loss of tolerance.

Similarly, with the new system, parts for a development model may be produced more quickly and in a form much closer to that planned for the production model. As a result, in critical areas such as missile manufacturing, AUTOPROMT can speed up the entire development and production cycle, and reduce its cost.

While mass production methods require the building of specialized machine tools, AUTOPROMT makes possible automation of short-run production with available general-purpose equipment, numerically controlled. The function of the machine tool is specialized for the job at hand by the description fed into a computer.

AUTOPROMT's concise, English-like language enables the part-programmer, working from an engineering drawing, to describe the surfaces to be milled in familiar shop terminology. The vocabulary contains 110 words with built-in latitude for assembling "sentences" and "paragraphs." Using the language, the part-programmer describes each geometric surface of the shape to be machined, defines the relationships of these surfaces to each other and specifies the machining requirements such as tolerances and tool size. For example, the programmer might use this statement to define a bowl-shaped surface of a part to be machined: "Bowl = sphere, inside center (0, 0, 0) radius (1.75)," which tells the program all it needs to know about the characteristics of the bowl-shaped surface. Other statements describe the relationship of this surface to other surfaces of the part.

The part description, handwritten on an AUTOPROMT coding sheet, then is punched into cards. The cards, in turn, are fed into the computer, which, under the control of the program, automatically generates the tool travel instructions for each surface to be machined.

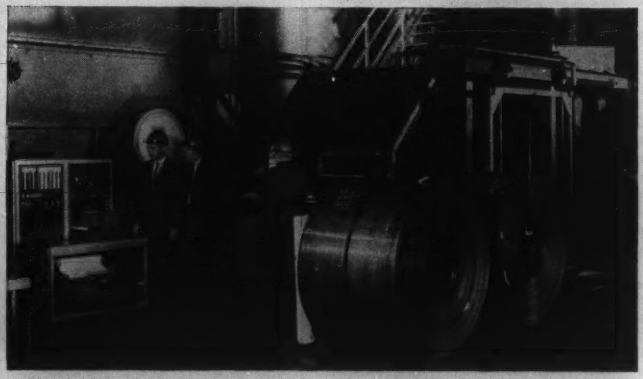
The final stage of the computer run, known as post-processing, edits the tool path information. The post-processor is not an integral part of the system, since it must be tailored to meet the needs of the particular type of numerical control equipment being used, but AUTOPROMT is compatible with various types of post-processing programs.

Tool paths generated are recorded by the computer on magnetic tape. If required, this is converted to perforated tape or other medium appropriate for input to a machine director, which numerically controls the operation of the tool.

AUTOPROMT's diagnostic abilities enable the computer to indicate by printed reports many types of errors which occur in the part description. For further verification, a printed list of co-ordinates for each tool position is prepared by the computer. These positions can be read or plotted to enable a manufacturer to visualize the path of the tool.

Numerically controlled machine tool cuts surface of helicopter gearbox cover. Computer, controlled by master program, automatically generates paths a tool must follow to mill complex 3-dimensional surfaces of the part. Programmer provides only a simple description of part to be milled and tool to be used. Computer-generated instructions are converted to perforated tape or other suitable medium for use by numerical control device

Steel-Rolling Mill Writes Its Own Production Reports



Operator's control station for four-stand tandem cold-rolling mill at Brackenridge Works of Allegheny Ludlum Steel Corp. is shown at extreme left. New system provides automatic logging of production data, saves time, and increases accuracy of the recorded information

Data are made more readily available for required production reports and for accounting purposes with an automatic typewriter and punched tape in use at an electronically controlled steel-rolling mill. The new system of automatic data logging in use at the Brackenridge Works of Allegheny Ludlum Steel Corporation has the added advantage of increasing the amount and accuracy of the information recorded.

Information recorded during the steel-rolling process includes: gage of steel before and after rolling; customer order data; type of finish and melt number; month, day, shift, hour, and minute of starting to roll each coil; identification of operator; width of steel; weight of coil before and after rolling; elapsed time for rolling; elapsed time of any delays and the cause of delays. Such information is of great value in determining product mix, average rolling times, calculation of payroll data including incentives, product yield, production costs, major causes of down-time, calculation of mill capacity, and similar factors.

An important feature of the system is that the mill operator can tell by a glance at the typewritten read-out chart whether material is being rolled to specific tolerances. Routine production reports which previously required as much as 2 days to be processed and returned to the production department can now be prepared within a few hours.

One of the most useful items logged as a part of the production record is the reason for a delay. The system contains a panel with which the operator can record any of more than 60 circumstances requiring stoppage of the mill simply by pushing appropriate buttons. Once a halt in production is recorded, the mill cannot be restarted until the operator enters the reason for the delay.

Reading Device for Blind

A reading device which utilizes a computer is being developed to enable the blind to read ordinary printed matter by translating the patterns of printed letters into patterns of music-like tones.

First, the computer is "taught" the shape of each of the letters of the alphabet, then to behave as though it were a group of photocells capable of recognizing its newly acquired alphabet; finally an experimental reading device is coupled directly to the computer so that computer and reading device act as a single machine. An array of miniature photocells is used to pick up the patterns of the letters. When sufficiently darkened by a part of a letter, each photocell turns on an oscillator which generates a specific pitch —an action similar to pressing a key on an electric organ. Each letter is represented by a sequence of chord-like tone combinations which the blind, with training, can interpret.

The problem was to find a photocell array that would generate the most distinctly recognizable combination of tones for each alphabet letter. An IBM *650* simulates the action of the photocells and activates the oscillators on the reading device. Thus different types of photocell arrays can be investigated simply by programming the computer.

The difficulty was in programming the letters of the alphabet and the combinations of photocells in a way that would provide interaction between the programmed letters and the programmed photocells. Each letter was broken down into bits by placing it under a screen made up of 119 rows and 104 columns. A square in the screen was considered ON if a predetermined amount of it was covered by a part of the letter. Five photocell arrays are being simulated in the initial programming.

Lead wires from the light sockets on the computer read-out panel are connected to the on-off oscillator switches. The series of tones produced are tape recorded. The tapes will be played to determine which set of tones is the most easily recognizable, and only these will be incorporated into

Light and dark patterns produced by the alphabet letters are picked up by a hand-held photocell probe and fed to a computer

actual reading machines for evaluation by the blind.

The National Institute of Health and The Veterans' Administration are sponsoring this research at Batelle Memorial Institute, Columbus, Ohio.

New Principle Makes Transformers Quieter

A new method of reducing sound produced by transformers—by "uncoupling" of vibration-energy conducting paths within the transformer—has been developed and successfully applied, according to the Pennsylvania Transformer Division, McGraw-Edison Company, Canonsburg, Pa.

Vibration energy, generated by magnetic action in the core of a transformer, reaches tank surfaces through the liquid insulator and through the core supports, both efficient conducting paths for vibration energy. By destroying the effectiveness of these conducting paths, some of the vibration energy can be contained within the transformer. It does not reach the tank surfaces where it would be radiated as sound.

According to Pennsylvania's engineers, the new sound-reduction method utilizes "compliant elements" that introduce a resilient medium in the liquid path. Thus, they shield the tank surfaces by "complying" with dimensional changes of the core. Only a portion of the vibration energy reaches the tank surfaces through the liquid. The core-and-coil assembly is uncoupled from the tank at points of support by "floating" the assembly on springs or other suitable supports.

The principles of the compliant-element system of sound reduction are said to have been established by extensive tests on models in Pennsylvania Transformer's Thomas A. Edison Acoustical Research Laboratory, and by application to production transformers (only to core-form units to date). Sound-level reductions of 8 to 12 db are being secured consistently.

Experimentation is still continuing on materials, shapes, and arrangements of resilient gas-filled enclosures—the compliant elements of the system. Application to a transformer is said to have little, if any, effect on its size or weight.

Computer Indexes Documents By Significant Title Words

Important words in the titles of scientific documents are indexed by an IBM *7090* digital computer in a system in operation at Bell Telephone Laboratories. Titles are fed to the computer on punched cards together with other cards containing the names of authors and identification numbers. The computer is programmed to scan the cards, reorganize the information and print out a "Permuted Title" subject index.

In the permuted index, each significant word of a title appears, in turn, as a key word in the index. The word is listed alphabetically at the index position in context with other words of the title. For example, the title "Application of the Fourier Integral in Circuit Theory" appears in three places in the index. It is shifted progressively so as to bring a different significant word to the index position.

The computer is instructed to ignore such unimportant words as are considered to have little value as index words. These may include prepositions, conjunctions, articles, verb forms, adjectives, and some nouns. A table of nonsignificant words is stored in the computer's memory and can be changed easily.

The computer stores each permuted title in its memory. When all the titles have been permuted, the computer reshuffles them and produces an index on magnetic tape in which all the titles are listed alphabetically according to the key word. The tape is then fed to a high-speed printer which prints out the titles at a speed of 600 lines per minute.

Pages from the printer can be reproduced by photo-offset and bound into an index book without the need for retyping or typesetting. In a typical application, the computer took only 12 minutes to index 1,700 documents according to title, author, number, and project.

Tower of Light Planned for New York World's Fair

Concentrated light developed by 24 "light cannons" each of one billion candlepower will send a tower of light straight up into the sky at the 1964-1965 New York World's Fair.

Planned as part of the investor-owned electric utility companies' exhibit at the Fair, the tower of light will be based in a rainbow-colored building 80-feet high located on the main traffic artery from the principal entrance to the Fair. The tower is expected to be visible from as far away as Boston, Massachusetts.

Artist's conception of 24-billion-candlepower tower of light made public at the Edison Electric Institute's recent convention

Future Meetings of Other Societies

18th Annual Congress of Pure and Applied Chemistry, August 6-12, Montreal, Que., Canada (write Chairman, Central Committee), National Research Council Ottawa, Ont., Canada.

1962 Conference on Standards and Electronic Measurements, August 14-16, National Bureau of Standards Laboratories, Boulder, Colo. Dr. J. M. Richardson, Chief, Radio Standards Lab., NBS, Boulder, Colo.

2nd International Electronic Circuit Packaging Symposium, August 16-18, University of Colorado, Boulder, Colo. Bureau of Continuation Education, Univ. of Colorado, Boulder, Colo.

5th International Conference on Coordination Chemistry, Aug. 21-Sept. 1, Wayne State University, Detroit, Mich. Prof. S. Kirschner, Chemistry Dept., Wayne State University, Detroit 2, Mich.

Western Electronic Show & Convention, Aug. 22-25, Cow Palace, San Francisco, Calif. Don Larson, WESCON Mgr., 1435 La Cienega Blvd., Los Angeles 35, Calif.

Joint International Conference on Creep and Fracture, Aug. 25-28, Hotel Biltmore, New York, N. Y. American Society of Mechanical Engineers, 29 W. 39 St., New York 18, N. Y.

8th Annual Summer Symposium, Oak Ridge Institute of Nuclear Studies, Aug. 28-30, Gatlinburg, Tenn. Symposium Office, University Relations Div., P. O. Box 117, Oak Ridge, Tenn.

International Heat Transfer Conference, Aug. 28-Sept. 1, University of Colorado, Boulder, Colo. L. S. Dennegar, Dir. of Pub. Rel., American Society of Mechanical Engineers, 29 W. 39th St., New York 18, N. Y.

AMS, Summer Meeting, Aug. 29-Sept. 1, Oklahoma State University, Stillwater, Okla. American Mathematical Society, 190 Hope St., Providence 6, R. I.

3rd Annual AIME Semiconductor Conference, Aug. 30-Sept. 1, Ambassador Hotel, Los Angeles, Calif. W. V. Wright, Electro-Optical Systems, Inc., 125 N. Vinedo Ave., Pasadena, Calif.

Overseas

UN Conference on New Sources of Energy, Aug. 21-31, Rome, Italy. United Nations Press Services, Office of Public Information, United Nations Building, New York 17, N. Y.

8th Annual International Meeting, TIMS, Aug. 23-26, Palais des Congres, Brussels, Belgium. H. H. Cauvet, Executive Director, The Institute of Management Sciences, 250 North St., White Plains, N. Y.

Convention on Impact of Nuclear Development on Electricity Supply and Instrument Techniques, Sept., London, England. Institution of Electrical Engineers, Savoy Place, London W. C. 2, England.

Versatile Basic Chemical Developed

"Baymal" colloidal alumina, a versatile addition to the inventory of basic chemicals available to industry, was announced recently by Du Pont's Industrial and Biochemicals Department.

Research chemists who developed Baymal say it has more unique properties and use possibilities than any chemical to emerge from their laboratories in many a year. To illustrate this versatility they point to the fact that in one form Baymal is hard enough to machine steel or cut glass, while in another form it can be used to improve the smoothness of a skin lotion.

Chemically, Baymal is a white, free-flowing powder, consisting of clusters of minute fibrils of boehmite (A100H) alumina.

Unusual Properties

The product owes its wide spectrum of potential applications to the following combination of properties:

1. It is a water-dispersible powder. Baymal disperses and swells up in water to form a stable colloid.

2. It consists of fibrillar particles. When a colloidal dispersion of Baymal is dried from water onto a surface, the small fibrils lie flat and interlace to form a film. Very few inorganic materials and no other aluminas form films in this manner. Such films remain stable at high temperatures.

3. Particles of Baymal are extremely small and have a high surface area. If the fibrils in 1 pound of Baymal were laid end to end, they would make 25 round trips to the sun. The surface area of these same fibrils would cover 30 acres.

4. When dispersed in water, fibrils of Baymal colloidal alumina assume a positive charge. Because of this positive charge, Baymal can fix itself to negative surfaces such as glass, paper, clay, etc., completely changing their surface charge from negative to positive.

5. Baymal is hydrophilic and organophilic. Because it is wet both by water and certain organic liquids, it can act as an emulsifier and a thickening, dispersing, and suspending agent in both water and water-alcohol systems.

6. Baymal has a low toxicity. Du Pont is applying to the Food and Drug Administration currently to obtain clearance for the use of Baymal in cosmetics and pharmaceuticals.

A dilute solution of Baymal in water assumes viscosity characteristics that are most unusual. A 4% dispersion, for example, can be changed from a very fluid solution to a very viscous sol or paste through a slight change in acidity. These viscous sols and pastes are highly thixotropic. In such a state, a gel remains in solid form until shaken or agitated, which causes it to turn into a liquid. On being allowed to stand, the liquid again becomes a solid gel. This reversible transformation can be reproduced any number of times, and the time required for the gel to set up can be tailored from less than a second to more than a day. Du Pont claims that Baymal is the most thixotropic material known to them.

Computer Controls Production of Carbon Resistors

Statistical quality control is combined with fully mechanized processing in a new computer-controlled system for the automatic manufacture of deposited carbon resistors. In use at the North Carolina Works of the Western Electric Company, the new system eliminates contamination problems, increases production, and permits a high level of reliability to be attained.

Automatic inspection station checks resistors for proper resistance value which appears as a reading on the visual monitoring graph

In addition to controlling step-by-step details of manufacture, the computer can accept a production schedule for a full month's output. It automatically issues detailed instructions to the fabricating machines to make and package any or all of four basic power sizes of resistors in such quantities and resistance values as may be desired.

The resistors look like tiny black firecrackers with copper wire "fuses" extending from the ends. Each consists of a short ceramic rod or core which is first coated with carbon. A conductive gold coating is applied to each end of the core for attaching a cap and wire terminal. Then a spiralled groove is cut into the carbon film to change the electrical path on the core and raise the resistance to the desired level. Finally, the resistor is encased in a cylindrical epoxy plastic cover for protection.

The machines work on a 3-second cycle, producing a resistor during each cycle. Maximum production rate is 1,200 finished resistors per hour. There are 11 machine stations on the line in addition to the computer and control cabinets.

Tidal Electric Stations in the USSR

According to B. Miroschichenko and Y. Stepanov who write from Moscow, within the next three years commercial electric current will be produced by the USSR's first tidal electric station now being built at Kislaya Guba on the Murmansk coast. During the construction and operation of this 1,200-kw experimental station with a 30-meter dam, engineers will study the main problems connected with erecting tidal electric stations. Full use of the energy from rivers in the European part of the Soviet Union is expected within 10 to 15 years.

In the same way, the inexhaustible source of energy contained in the ocean is expected to be utilized.

Just before the outbreak of World War II, research was conducted on the Kola Peninsula and on the White Sea coast. The results showed that tidal electric stations (TES) in these areas was possible. With the development of the country's northern and eastern areas, the question arose of supplying them with electricity. A group of engineers of the Gidroenergoproekt Institute under L. B. Bernstein (M.Sc. in Engineering) is preparing the designs for TES's on the Murmansk coast and on the White Sea.

At some spots on the sea coast the tide is up to 18.5 meters high. In the Sea of Okhotsk it reaches 9 to 11 meters, and in the White Sea 8 meters, but until recently the ocean has not been used for large-scale generation of electricity.

Operating Principle

How will the tidal electric station operate? A bay connected with the sea by a narrow channel is selected and blocked by a dam, thus transforming the bay into a TES reservoir. By opening the sluices during high tide, the water level in the reservoir will rise to its maximum point. When the sluices are closed, the reservoir water levels and those of the sea vary. By releasing the water into the sea through a turbine, the latter is set in motion, and the turbine's generator starts producing electricity. The water level in the reservoir drops to that of the sea. At next high tide the reservoir is again under the pressure of the sea.

In the operation cycles of a TES, much electricity is produced within a short period but the consumer requires a steady supply. When a TES becomes part of a large power system, the turbine may be made to work as a water pump, creating additional pressure to be used when necessary.

For the Kislaya Guba TES, a rapid method of assembling the dam has been proposed: the main parts of the station are assembled from thin-walled reinforced concrete panels similar to floating docks and transported by sea to the site, and there the block units will be filled with ballast and submerged.

The erection of tidal electric stations is no longer a dream. The Lumbovskaya TES, with a capacity of several hundred thousand kilowatts and with a 5-kilometer dam is being designed. Tidal energy is under study in Mezen Bay, where it is planned to build an even more powerful TES. The designs of a gigantic White Sea TES are being prepared. The station's 100-kilometer dam which will separate part of the Mezen Bay from the White Sea will have 2,000 turbine units with a total capacity of several million kilowatts, supplying the single power system of the European part of the USSR with billions of kw-hours of electricity annually.

NEW BOOKS

The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

ADVANCES IN ELECTRONICS AND ELECTRON PHYSICS, vol. XIII. Edited by L. Marton, Academic Press, Inc., 111 Fifth Ave., New York 3, N. Y., 1960. 454 pages, 6 by 9¼ inches, bound. $13.50. Those aspects of electronics and electron physics covered in this volume include inelastic collisions between atomic systems, field ion microscopy, velocity distribution in electron streams, electron probe microanalysis, and television camera tubes.

CREATIVE ENGINEERING ANALYSIS. By F. L. Ryder, Prentice-Hall, Inc., Englewood Cliffs, N. J., 1961. 281 pages, 6¼ by 9¼ inches, bound. $9. Designed to bridge the gap between conventional textbook problems and those which confront practicing engineers, this book discusses the recognition and definition of a problem, the selection of the essential parameters, and the translation of mathematical analysis into meaningful physical conclusions. Many problems and detailed solutions are given, particularly in mechanics, strength of materials, and electricity and electronics. Also included is a compilation of tricks and devices of analysis which the author has found useful.

DICTIONARY OF ELECTRONICS. By Harley Carter. Pitman Publishing Corp., 2 W. 45th St., New York 36, N. Y., 1960. 377 pages, 5 by 7½ inches, bound. $7.50. Terms were selected for this dictionary on the basis of their relation to the basic facts of electronic science as first choice. To these have been added explanations of many familiar electrical terms described in the light of modern scientific concepts. Finally, appendixes present much supplemental information: units, abbreviations, Greek letters, graphical symbols and letters, and color codes, used in electronics and standardized as various British Specifications; decibel conversion and frequency wave length conversion tables; electromagnetic spectrum; valve bases; and rationalized MKS units. The definitions reflect British practice, but also include recognition of an American term if it appears to be gaining precedence, as in "wireless" and "radio."

THE DIELECTRIC CIRCUIT. By Philip Kemp. Chapman and Hall Ltd., London, England, 1960. 219 pages, 5½ by 8¾ inches, bound. 45s. With the development of high-voltage engineering the subject of dielectric phenomena has taken on an increased importance. This volume does not attempt to describe actual installations, but concerns itself primarily with the basic principles of the dielectric circuit. The author discusses capacitors on alternating voltage, capacitance in 3-phase systems, potential gradient, potential gradient with cylindrical conductors, transients in capacitive circuits, impulse voltages, and dielectric measurements.

ELEMENTS OF NUCLEAR ENGINEERING. By Glenn Murphy, John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1961. 213 pages, 6 by 9¼ inches, bound. $7.50. A general survey is given of radiation, fission, fusion, and other nuclear transformations, with indications of how these transformations may be exploited in industrial and engineering applications. Beginning with a discussion of the concepts, principles, and ideas necessary for an engineering understanding of nuclear transformations and of radiation, the text continues with a simplified presentation of modified one-group theory of homogeneous, bare, thermal reactor cores. It concludes with a review of radiation, its measurement, and the hazards associated with it.

ERROR-CORRECTING CODES. By W. W. Peterson, John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1961. 285 pages, 6 by 9¼ inches, bound. $7.75. Error-detecting and error-correcting codes for information transmission and storage systems are discussed. The implementation of codes in practical systems is considered in detail, with emphasis on types of codes that have mathematical, especially algebraic structure. The mathematics necessary for an understanding of coding theory is included in the book. Five appendixes provide useful supplementary information, including a table for the entropy function and a table of irreducible polynomials over GF(2).

FOUNDATION FOR ELECTRIC NETWORK THEORY. By M. B. Reed. Prentice-Hall, Inc., Englewood Cliffs, N. J., 1961. 354 pages, 6¼ by 9¼ inches, bound. $9.75. A major innovation in this text on network theory is the use of resistive networks only. D-c and a-c theories are merged, with the basis of the presentation being abstract linear graphs and matrices. In particular, it provides the basis of 2-, 3-, 4-, and n-terminal network theory, a basis for assessing and reorganizing design technique for effective use of digital computers, and a basis for power system planning.

THE HALL EFFECT AND RELATED PHENOMENA. By E. H. Putley. Butterworths, Inc., 7235 Wisconsin Ave., Washington 14, D. C., 1960. 263 pages, 5½ by 8¾ inches, bound. $9.50. Recent developments in the study of electronic conduction in semiconductors are described. Conduction properties and the experimental techniques for measuring them, the formal theory of conduction, and an interpretation of experimental results are discussed. The behavior of the principal groups of semiconductors are reviewed and their properties summarized.

LINES, WAVES, AND ANTENNAS. By Robert Grover Brown and others. The Ronald Press Co., 15 E. 26th St., New York 10, N. Y., 1961. 297 pages, 6¼ by 9¼ inches, bound. $10. The general area of electric energy propagation is covered in this volume, which discusses lossless lines and their analysis, transmission line matching, lossy-line analysis, field equations, propagation of plane waves, guided waves, lossy-wave propagation, radiation of electromagnetic waves, and antenna systems. In general, emphasis is placed on theoretical fundamentals rather than on hardware.

DIE METALLISCHEN WERKSTOFFE DES MASCHINENBAUES. By E. Bickel. Third edition. Springer Verlag, Berlin, Germany, 1961. 439 pages, 6¾ by 10 inches, bound. DM 37.50. This is a text covering the entire range of metals and alloys, intended to give mechanical and electrical engineers a knowledge of basic metallography and to familiarize them with the reference works and special literature of the field. The four main divisions of the book deal respectively with crystal structure, alloys, properties as they affect use, and specific materials and their applications.

NUCLEAR REACTOR CONTAINMENT BUILDINGS AND PRESSURE VESSELS. Published by Butterworths, Inc., 7235 Wisconsin Ave., Washington 14, D. C., 1960. 572 pages, 6¼ by 10 inches, bound. $18.50. 22 papers and discussions devoted to the analysis, design, construction, and testing of containment buildings and pressure vessels of the type used in nuclear power plants. The papers were presented at an international symposium held in Glasgow, Scotland, in 1960.

PAST EXAMINATIONS FOR PROFESSIONAL ENGINEER. Compiled and published by J. D. Constance, 625 Hudson Terrace, Cliffside Park, N. J., 1961 edition. Various pagings, 8½ by 11 inches, loose-leaf. $1.50. This is a compilation of examinations for Professional Engineer given by the New York State Board of Examiners during the period January 1953 to February 1961. Over 1,000 questions in all categories are given. Structural planning and design, basic engineering sciences, and individual categories of engineering are covered.

POWER REACTOR TECHNOLOGY. Edited by J. K. Pickard and others. D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N. J., 1961. 417 pages, 6¼ by 9¼ inches, bound. $11.25. Drawing upon the many excellent papers of the 1958 Geneva Conference on the Peaceful Uses of Atomic Energy, which reviewed the prototype nuclear power projects initiated by the 1955 Conference, this volume describes aspects of the current state of nuclear power development. It is a convenient reference on the initial design approaches employed on the leading power plant concepts. The 10 chapters deal with the economic outlook for nuclear energy sources, boiling water reactors, pressurized light-water-cooled reactors, gas-cooled reactors, heavy-water power reactors, organic moderated reactors, sodium-cooled graphite-moderated reactors, fast reactors, homogeneous aqueous reactors, and safety and containment.

THE PRINCIPLES OF NUCLEAR MAGNETISM. By A. Abragam. Oxford University Press, 417 Fifth Ave., New York 16, N. Y., 1961. 599 pages, 6¼ by 9½ inches, bound. $13.44. The principles and methods of nuclear magnetism are reviewed. Although the outlook is mainly theoretical, a large amount of experimental evidence is included for the sake of comparison with the theory. The author discusses motion of free spins, dipolar line width in a rigid lattice, spin temperature, electron-nucleus interactions, fine structure of resonance lines, thermal relaxation, theory of line width in the presence of motion of the spins, and multiplet structure of resonance lines in liquids.

PRODUCTION FORECASTING, PLANNING, AND CONTROL. By E. H. MacNiece. Third edition. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1961. 402 pages, 6 by 9¼ inches, bound. $9.75. Intended primarily as a textbook, this description of basic principles and the manner of their application will also be useful to industrial management. The author concentrates on the techniques and principles of forecasting, planning, and control, but also discusses the relationship to and application of other subjects in the practice of production engineering—such subjects as automation, electronic data processing, and financial planning—and the relations of production engineering with other departments of industrial organizations. This third edition presents new material on sales forecasting, warehouse distribution and control, economic lot sizes, and military production planning and control, as well as a general revision of repeated material.

PROGRESS IN OPERATIONS RESEARCH, Vol. I. Edited by R. L. Ackoff. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y., 1961. 505 pages, 6 by 9¼ inches, bound. $11.50. Mathematical techniques and research methods available to operations researchers are reviewed. The primary emphasis is on the development of modelling techniques and their application to problem solving in eight important areas of operations research: inventory theory, linear programming, dynamic programming, queuing theory, sequencing theory, replacement theory, simulation, and gaming. For each of these areas the current "state of the art" is evaluated, important applications are surveyed, and unsolved problems are discussed.

PROGRESS IN SEMICONDUCTORS, Vol. 5. Edited by A. F. Gibson. John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1960. 316 pages, 6 x 9¼ inches, bound. $11. The present state of knowledge in semiconductors is critically reviewed, with some emphasis on the optical properties of semiconductors. The subjects covered include the electrical properties of semiconductor surfaces, the absorption edge spectrum of semiconductors, the chemical bond in semiconductors, indium antimonide, thermal conductivity of semiconductors, magneto-optical phenomena in semiconductors, and the band structure and electronic properties of graphite crystals.

RADIO WAVES IN THE IONOSPHERE. By K. G. Budden. Cambridge University Press, 32 E. 57th Street, New York 22, N. Y., 1961. 542 pages, 6¼ x 9¼ inches, bound. $18.50. Based on annual lectures at the University of Cambridge, Dr. Budden's book is an advanced exposition of the mathematical basis of the theory of propagation of radio waves in a horizontally stratified ionosphere. The first half of the book deals with the "ray theory"—homogeneous ionized media and the reflection of high-frequency radio waves at vertical and oblique incidence. The second half deals with the "full wave theory"—which is used when the ray theory fails—on the reflection of radio waves of very low frequency. In order to

isolate fundamental methods as clearly as possible, the author excludes some important topics which deal with variables in practice, but do not alter fundamentals.

SCIENTIFIC THINKING AND SCIENTIFIC WRITING. By M. S. Peterson. Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y., 1961. 215 pages, 6¼ by 9¼ inches, bound. $6.95. Addressed mainly to students in the biological and physical sciences, this book is based on the premise that good expository prose cannot be written without knowledge and application of the general logic of science. To instill these requisites, Dr. Peterson here presents the essence of traditional inductive logic, the logic of several special methods, the role of hypothesis, and the general pattern of complete scientific investigation in relation to the development of a professional background for scientific writing. The final chapter describes various types of scientific writing and thinking.

SEQUENTIAL DECODING. By J. M. Wozencraft and Barney Reiffen. John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1961. 74 pages, 6 by 9¼ inches, bound. $3.75. The electrical communications problem of coding and decoding is considered from the probabalistic point of view, and a data-communication procedure is presented for which the average computational complexity grows only algebraically with delay. This decoding scheme, called sequential decoding, is considered in detail with respect to binary symmetric channel. Its extension to more general channels is discussed briefly.

SYMPOSIUM ON RADIATION EFFECTS AND RADIATION DOSIMETRY. Published as ASTM Special Technical Publication No. 286 by the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa., 1960. 156 pages, 6 by 9¼ inches, bound. $4.75. This symposium presents some of the latest research on the effects of radiation on materials properties, as well as discussions of parameters to be considered in predicting and evaluating such effects. Also presented are new techniques for radiation measurement.

THEORIES OF ENGINEERING EXPERIMENTATION. By Hilbert Schenck, Jr. McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N. Y., 1961. 239 pages, 6¼ by 9¼ inches, bound. $7. This basic text emphasizes general principles rather than laboratory equipment, describing techniques useful in mechanical, electrical, and civil engineering. The sequence of topics discussed follows the sequence of the experimental method: error in a single instrument and in a complete test, with special reference to selecting instruments that are completely logical errorwise, and to minimizing uncertainties when planning a test reduction of test variables through dimensional analysis and the pretest spacing of these variables; sequence of data taking and the problem of extraneous variables and control; apparatus malfunction and inconsistency in the developing data during the test; and statistical, graphical, and numerical methods of reducing, studying, and interpreting engineering data.

TRANSMISSION OF INFORMATION. By R. M. Fano. John Wiley and Sons, Inc., 440 Fourth Ave., New York 4, N. Y., 1961. 389 pages, 6 by 9¼ inches, bound. $7.50. This text is devoted to that aspect of communication theory originating from Shannon's work. It provides an up-to-date treatment of coding theory that emphasizes the formulations and mathematical techniques that have proved to be of greatest engineering significance. Aspects discussed include measure of information, simple message ensembles, discrete stochastic sources, transmission channels, channel encoding and decoding, encoding for binary symmetric channels, and encoding for discrete, constant channels.

ADVANCES IN THE ASTRONAUTICAL SCIENCES. *Volume 6.* Published by the Macmillan Co., 60 Fifth Ave., New York, N. Y., 1961. 898 pages, 7 by 10¼ inches, bound. $25. The 57 papers included in this volume constitute the proceedings of the sixth annual meeting of the American Astronautical Society, held in 1960. They cover such areas as communication in space, propulsion, guidance and control, space medicine and astrobiology, space flight mechanics, design of space vehicles, the problems of re-entry of space vehicles, and astronautical systems and space physics.

ALTERNATING-CURRENT MACHINES. By M. Liwschitz-Garik and C. C. Whipple. Second edition. D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N. J., 604 pages, 6¼ by 9¼ inches, bound. $15. The principal aim of this text for students and practicing engineers is to provide an understanding of the relationship that exists between the laws of electrodynamics and the performance characteristics of the transformer and rotating electric machines. Much of the material has been rewritten in this edition, and the text has been subdivided into many more chapters. In addition new material has been added, together with worked examples and a more complete set of appropriate problems. A thorough coverage of the subject is presented.

ATOMIC ENERGY WASTE. Edited by E. Glueckauf. Interscience Publishers, Inc., 250 Fifth Ave., New York 1, N. Y., 1961. 420 pages, 6¼ by 10 inches, bound. $14. This volume reviews the current knowledge concerning nuclear waste products and how they arise. Specifically, it discusses the effects of radiation on materials and living organisms, the legal aspects of atomic energy disposal, the operations involved in the treatment of radioactive waste, fission products as sources of radiation, and the uses of radiation in research and agriculture. Each aspect is discussed by a known authority within the respective subject area.

CIRCUIT ANALYSIS. By E. M. Sabbagh. The Ronald Press Co., 15 E. 26th St., New York 10, N. Y., 1961. 455 pages, 6¼ by 9¼ inches, bound. $8.75. The electric circuit is considered in detail, and the concepts of dielectric and magnetic circuits are introduced. Beginning with electric and magnetic fields, the author continues with inductance, capacitance, and resistance as defined in terms of field quantities and in terms of their volt-ampere relationship. The fundamental laws of circuit theory are then explained, and an introduction is given to such tools of circuit analysis as transformation theories, complex algebra, the complex frequency method, and the Fourier series. Some advanced concepts not usually found in an introductory text of this nature are also included.

THE CONSULTING ENGINEER. By C. M. Stanley. John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1961. 258 pages, 5¾ by 8¾ inches, bound. $5.95. The professional and management problems involved in the practice of consulting engineering are discussed. The first part is concerned with the consulting engineer's professional relationships with his client, other consultants, and the public. The second part deals with internal problems of a consulting practice. It considers the many areas of organization, personnel, plant facilities, procedures, and management situations with which the consulting engineer must cope. Emphasis is placed upon the problems relating to the operation of a consulting practice and not upon the technical problems involved in engineering and design. Sample contracts are appended.

CONTROL OF NUCLEAR REACTOR AND POWER PLANTS. By M. A. Schultz. Second edition. McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N. Y., 1961. 462 pages, 6¼ by 9¼ inches, bound. $12.50. The basic control problems of all types of reactors, from homogeneous to boiling reactors, are covered in this work. It has been revised and updated to give an account of the new concepts that have arisen since publication of the first edition. Major revisions are the inclusion of the effects of the Doppler coefficient in uranium oxide fueled reactors, a new chapter on elementary servomechanism techniques, a simplified graphical method of solving ramp reactivity problems, and complete transfer functions for all types of reactors in graphical and tabular form.

DESIGN FUNDAMENTALS OF ANALOG COMPUTER COMPONENTS. By R. M. Howe. D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N. J., 1961. 268 pages, 6¼ by 9¼ inches, bound. $7.50. Beginning with an over-all discussion of computer design philosophy, the author continues with an extensive discussion of computer component errors and how they influence problem solutions. Subsequent chapters are devoted to d-c amplifiers, multipliers, function generators, recorders, and miscellaneous equipment. Numerous examples of commercial equipment are included. A final chapter contains illustrative photographs of the various computer components discussed in earlier chapters.

Library Services

ENGINEERING Societies Library books, except bibliographies, handbooks, and other reference publications, **may be borrowed by mail by AIEE members for a small handling charge. The Library also prepares bibliographies, maintains search and translation services, and can supply** a photoprint or a microfilm copy of any item in its collection. Address inquiries to R. H. Phelps, Director, Engineering Societies Library, 29 W. 39 St., New York 18, N. Y.; after Sept. 5: UEC, 345 E. 47 St., New York, 17.

PRINCIPLES AND PRACTICE OF AIRCRAFT ELECTRICAL ENGINEERING. By H. Zeffert. George Newnes Ltd., London, England, 1960. 726 pages, 5¾ by 8¾ inches, bound. $25. This is a survey of the technical and installation problems encountered in aircraft electrical systems from the initial project stage to the time the aircraft is in operational service. The early chapters discuss environmental conditions, together with the various factors which influence the choice of a particular power system. Constant-frequency and variable-frequency a-c, low-, and medium-voltage d-c generation systems, and the associated control and protection devices are considered in detail. In subsequent chapters various aspects of power utilization and equipment and of control and indicating circuits are reviewed. Particular stress is placed on the practical aspects of design.

PRINCIPLES OF INERTIAL NAVIGATION. By C. J. Savant, Jr. and others. McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N. Y., 1961. 254 pages, 6¼ by 9¼ inches, bound. $9.75. A considerable amount of the unclassified material available on inertial navigation is covered. The book is divided into three parts. The first presents the components, co-ordinate systems, and errors which occur in inertial guidance systems. The second considers in more detail the autonavigator components and computers, platform controller, ground alignment, performance, and preflight testing. The third is mathematical in nature, and describes the various co-ordinate systems which can be used, system error analyses, and ballistic guidance. The first part of the book provides a suitable introduction for the person with little or no mathematical background.

TRANSISTOR LOGIC CIRCUITS. By R. B. Hurley. John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1961. 363 pages, 6 by 9¼ inches, bound. $10. Both logical mathematics and transistor logic circuits are presented in an integrated treatment. Beginning with elementary binary arithmetic and Boolean algebra, the author continues with minimization techniques and implementation concepts. This is followed by a basic treatment of diodes and transistors. A variety of application examples are employed to clarify the integration of the mathematics and devices into useful combinational circuits. The book concludes with sequential systems and the circuits appropriate to these systems.

SCHWANKUNGSERSCHEINUNGEN IN ELEKTRONENRÖHREN. By F. Ollendorf. Springer-Verlag, Vienna, Austria, 1961. 468 pages, 6¼ by 10 inches, bound. $22.85. This advanced text on fluctuation phenomena in electron tubes consists of four main parts: an extensive introduction presenting the essentials of probability theory, and three long chapters devoted respectively to the shot effect, fundamentals of wave mechanics, and the wave electronics of single electrons. Selected references for each part are given at the end of the book.

SCIENCE IN SPACE. Edited by L. V. Berkner and Hugh Odishaw. McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N. Y., 1961. 458 pages, 6¼ by 9¼ inches, bound. $7. The achievements of space science from the launching of the first Sputnik to the present time are reviewed. Coverage is given to rocket research in the upper atmosphere, how space vehicles can increase man's knowledge of the earth, experiments using space vehicles, prospects of life beyound the earth, the use of earth satellites for weather forecasting, and the problem of backward and forward contamination. In addition electromagnetic fields, particles, and radiations in interplanetary space, auroral theory and the magnetic fields of earth, sun, and space are discussed.

SYSTEMTHEORIE FÜR REGELLOSE VORGÄNGE. By Herbert Schlitt, Springer-Verlag, Berlin, Germany, 1960, 344 pages, 6¼ by 9¼ inches, bound. DM 49.50. This publication is a textbook on systems theory for random processes and on statistical methods for communications and control engineering. The first chapters present mathematical descriptions of processes with one and two independent statistical variables, of linear systems, and of time-dependent random processes. Following are sections on the relationship between the statistical characteristics of input and output signals in linear communication systems; and on control of stationary random processes by linear filters, etc. The final section deals with the synthesis of optimum communication systems, and there is a list of formulas in the appendix.

TECHNIQUES OF HIGH ENERGY PHYSICS. Edited by D. M. Ritson. Interscience Publishers, Inc., 250 Fifth Ave., New York 1, N. Y., 1961. 540 pages, 6¼ by 9¼ inches, bound. $16.75. This book consists of a series of papers dealing with the techniques and instrumentation used in high-energy physics. Techniques considered include diffusion cloud chambers, bubble chambers, nuclear emulsions, digital computers, ionization counters, scintillation and Cerenkov counters, use of transistors, beam optics, target preparation, and beam monitoring methods. The volume is intended to bridge the gap between the textbook and current research within the field.

TECHNICAL LITERATURE

The following recently issued technical literature may be of interest to readers of *Electrical Engineering*. All inquiries should be addressed to the issuers.

OSCILLATOR CIRCUITS. T. M. Adams. The first of several volumes in a new series on basic electronics. Four-color diagrams are utilized in conjunction with simple explanations of basic oscillator circuits. Chapter 1 is an introduction to the fundamentals of electronic circuit operation, and the 9 following chapters cover as many basic oscillator circuits. The 128-page book is available from Howard W. Sams & Co., Inc., 2201 E. 46 St., Indianapolis 6, Ind.; for $2.95.

EIA TECHNICAL STANDARDS. Three new technical standards have been published by the Engineering Department of the Electronic Industries Association. *Designations for Receiver-Type Tube Sockets*, EIA Standard RS-167-A, describes the significance of coded type designations for receiver-type tube switches. Information on methods of test and measurement are also included: 90¢. *Standard Test Methods for Electronic Component Parts*, EIA Standard RS-186-A, contains test methods for humidity, moisture resistance, and vibration fatigue, among others. Some of the tests given are applicable to equipments; $1.90. *Electrical Performance Standards for Television Broadcast Transmitter Channels 2-6 (54-88 mc), 7-13 (176-216 mc), 14-83 (740-890 mc)*, EIA Standard RS-240, is a revision of a former standard, expanded to include standards on the parameters of TV visual and aural transmitters for both monochrome and color TV. The standards mentioned may be ordered from Electronic Industries Association, 1721 DeSales St., N.W., Washington 6, D.C. (minimum order $1).

THE USE OF Q EQUATIONS TO SOLVE COMPLEX ELECTRICAL NETWORKS. By H. F. Fristoe, Ph.D. The third edition of publication No. 105 of this university's college of engineering is an enlargement of a previous publication of the same number and title. It discusses generalized amplitude and phase response of simple resonant networks in terms of Q equations. A number of resonant networks are analyzed; the π-network is discussed, and a nomograph type of design is presented. Priced at $2.50, the book is available from the Office of Engineering Research, Oklahoma State University, Stillwater, Okla.

PROCEEDINGS OF THE SIXTH CONFERENCE ON MAGNETISM AND MAGNETIC MATERIALS. A set of 149 papers presented at the November 1960, Magnetism Conference. Groups of papers dealing with pure and applied physics, correspond with the organization of the sessions of the conference, and provide a comprehensive review of both theory and practice. Topics include ordered spin systems, computer devices, metallic films, ferromagnetic resonance, microwave devices, and many others. The 395-page book, priced at $10, is available from McGraw-Hill Book Co., 330 W. 42 St., New York 36, N. Y.

IDEAL GAS THERMODYNAMIC FUNCTIONS AND ISOTOPE EXCHANGE FUNCTIONS FOR THE DIATOMIC HYDRIDES, DEUTERIDES, AND TRITIDES. National Bureau of Standards Monograph 20 is the result of a research program begun in 1951 by the Atomic Energy Commission to investigate, both theoretically and experimentally, isotope effects in hydrogen compounds. One phase of the program was the calculation and tabulation of thermodynamic and equilibrium exchange functions of hydride, deuteride, and tritide compounds and reactions. This monograph contains tables for these substances, and includes nearly all species for which adequate structural data are available through experiment or derivation. The book is available from the Superintendent of Documents, United States Government Printing Office, Washington 25, D. C., for $2.75.

FUNDAMENTALS OF U.H.F. By Allan Lytel. A comprehensive coverage of theory, equipment, and applications in the rapidly expanding field of ultrahigh frequency. The book is written at the intermediate level, and comprises a complete course for that portion of electronics that deals with ultrahigh frequency. Mr. Lytel discusses antennas, transmission lines, wave propagation, generators, communications equipment, and test equipment and techniques. FCC rules and regulations covering its use are also provided. Priced at $3.90, the 160-page book is available from John F. Rider Publisher, 116 W. 14 St., New York, N. Y.

PUBLICATIONS OF THE NATIONAL BUREAU OF STANDARDS. *July 1, 1957 to June 30, 1960. National Bureau of Standards Miscellaneous Publication 240* lists all publications of the NBS for the dates given. A brief abstract of each is included, as is a list of papers by Bureau authors which have appeared in non-Bureau publications. Subject and author indexes and general publication information are presented. The catalog included lists papers published from 1901 to 1957. Priced at $2.25, the book is available from the Superintendent of Documents, United States Government Printing Office, Washington 25, D.C.

THERMAL EXPANSION OF TECHNICAL SOLIDS AT LOW TEMPERATURES. *A Compilation from the Literature.* By R. J. Corruccini and J. J. Gniewek. National Bureau of Standards Monograph 29 was intended to fill a need among designers of cryogenic equipment for a compilation of thermal expansion data on cryogenic materials. Wherever possible, data are presented throughout the range from zero to 300 K. However, as the tables are derived from published data rather than experiment, substances usually used as cryogenic fluids are omitted. Priced at 20¢, the monograph is available from the Superintendent of Documents, United States Government Printing Office, Washington 25, D. C.

BIBLIOGRAPHY OF MAGNETIC TAPE RECORDING, *1954-1960 Inclusive.* A company that designs magnetic tape recording equipment has compiled a bibliography of published material in the field. Arranged alphabetically by title within each year, with names of authors, it includes a list of journals which publish articles on this subject. Both audio and visual recording are covered. Priced at $1, the booklet is available from Kinelogic Corp., 1256 N. Fair Oaks Ave., Pasadena, Calif.

ELECTRICAL AND ELECTRONIC TEST EQUIPMENT DATA HANDBOOKS. A new series of volumes for the aid of engineers in the selection of electrical-electronic test equipment comprises 11 books, including all available descriptions for 19 categories of test equipment. Functional description, electromechanical characteristics, reference source data, etc., are given for each product. The 19 classifications cover military and commercial instruments, primarily military. The complete set is more than 4,000 pages in length, priced at $200, and sold by Frederick Research Corporation, 2601 University Blvd., West Wheaton, Md.

THE PHYSICAL THEORY OF TRANSISTORS. By Dr. Leopoldo B. Valdes. Intended for use in graduate study of transistor physics and as a reference. The flow of current through semiconductor materials is analyzed, and relationships derived between the electrical characteristics and the physical structure of transistors. Other aspects of solid-state physics are discussed. Priced at $10.50, the 384-page book is available from McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N. Y.

OTS REPORTS. The following publications have been made available to the public by the Office of Technical Services. *Proceedings of the Uranium Carbide Meeting Held at Oak Ridge National Laboratory, December 1-2, 1961.* The 162-page report of this meeting, which includes a number of charts and photographs, covers various subjects in the field, including developments here and abroad. Order No. *TID-7603*, $1.75. *The Practical Application of Space Nuclear Power in the 1960's.* J. R. Wetch and others. The major operational, installation, and handling characteristics of three small nuclear reactors designed to meet electric power requirements in future space vehicles are discussed. Order No. *TID-6312*, 50 pages, $1.25. *Research on High-Temperature Complex Component Development.* This 80-page report describes a new microminiaturization process which extends printed circuitry to include capacitors and resistors. Order No. *PB 171 380*, $2. *Electron Induced Radiation Damage in Pure Metals.* R. M. Walker. This is a report on the results of electron bombardment of metals at low temperatures. Both production and recovery processes are discussed. Order No. *PB 171 523*, $1.25. *A Lunar Power Plant.* R. H. Armstrong and others. This is a description of an ultracompact nuclear power plant that could be assembled on earth, transported by rocket, and operated on the moon. Order No. *ANL-6261*, $2.50. *Research on High-Temperature Polymers.* J. B. Rust, et al. This 124-page book is the report of an investigation to develop new high-temperature-resistant inorganic polymers, which resulted in the synthesis of two general categories of metalloxane polymers. Order No. *PB 171 522*, $2.75. *Neutron Cross Sections in Zirconium, April, 1961.* This news letter is devoted entirely to zirconium cross-section data. Order No. *BNL-666 (T-220-40-1)*, 50¢.

NATIONAL COIL'S TESTING KNOW-HOW HELPS ECONOMIZE ON FIELD COIL RECONDITIONING

These field coils for a 3500-hp D.C. steel mill motor were reconditioned by National on a rush basis—10 days from pick-up to delivery. The work included cleaning and testing, dipping and baking, and replacement and reinsulation where required.

Despite the rush nature of the job, National applied its usual thorough testing. Considerable savings resulted to the customer. The customer had made a-c tests in his mill indicating pole face windings were OK but National also made d-c polarization index tests showing insulation was not satisfactory. After thorough drying, varnishing and baking, further tests assured insulation was fully restored without replacement.

In this application, National's know-how prevented future trouble—but avoided the expensive way of correcting it. The same know-how can assure you of maximum dependability on your coil or rebuilding jobs. For information contact National's Columbus plant... HUdson 8-1151... or check the nearest National field engineer.

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McGRAW EDISON

Trade Literature . . .

High-Speed Magnetic Counter . . .

A quick reset counting device, the Series *1591* high-speed magnetic counter for remote indication of equipment operation, is fully described and illustrated in a new 4-page bulletin. Included is a list of typical applications where this electrically actuated counter proves profitable to both equipment manufacturers and users, such as business machines, vending equipment, conveyors, electric-eye equipment, meters, and a wide variety of machines. Timing of contact coordinates is discussed, and standard specifications given both in tabular form and by means of engineering drawings. A photograph illustrates the external appearance of the unit. For a free copy write to *Veeder-Root Inc., 70 Sargeant St., Hartford 2, Conn.*

"Counter Points" . . .

Counter Points is the title of a new external house organ now being published by the Erie-Pacific, manufacturers of digital counting, timing and control systems. The new publication assists design, production, and laboratory engineers working in the control segment of industry. It provides information on applications using the company's line of counter-timers and control instruments. Technical data are provided on new instruments as well as miscellaneous information of value to engineers working in this field. Engineers desiring copies may be placed on the company's mailing list without cost by writing to *Sales Department, Erie-Pacific, Div. of Erie Resistor Corp., 12932 South Weber Way, Hawthorne, Calif.*

"Cain Circuit" . . .

The first issue of a new technical instrumentation quarterly—the *Cain Circuit*—contains technical articles on a-c power, radar simulation, and particle counting for white room contaminant measurement. The a-c power article describes the use of a frequency-amplitude modulator designed to simulate the widely varying power supply frequencies of an airborne fire control computer. The article on radar simulation describes a beacon test set. The first of a series of three articles on the measurement of white room contaminants reviews the general problems of this field, and describes the principles of particle counting and detection used in an optical system. The quarterly may be obtained by writing to *Cain & Company, 2615 West Magnolia Blvd., Burbank, Calif.*

Variable Transformers . . .

Although a relative newcomer in the variable-transformer field, Ohmite Manufacturing Company has received Underwriter's Laboratories approval on two series of transformers. Approved are the Series *VT4* units and Series *VT8* units. Series *VT4* units are rated 3.5-ampere nominal with overvoltage feature; 4.75-ampere without overvoltage. Series *VT8* units are rated 7.5-ampere nominal with overvoltage; 10.00 ampere without overvoltage. The approval applies to uncased, cased, and various ganged assemblies in these models. These transformers also feature mounting versatility and are mechanically and electrically interchangeable with other popular brands. For Bulletin *151* write to *Ohmite Manufacturing Company, 3682 Howard St., Skokie, Ill.*

Automatic Transfer Switches . . .

Mechanically held automatic transfer switches are now manufactured in 1,200-, 1,600- and 2,000-ampere sizes by the company. These 2- and 3-pole switches are catalog-listed to 600 volts a-c, 250 volts d-c. These switches are open type, minimum width, vertical tandem types, particularly suitable for control centers. Full relay protection on each switch provides for transfer to the emergency source when voltage on any phase drops to 70% or less. Retransfer to the normal will be made when all phase voltages are 90% or more. On single-phase or d-c, 3-wire systems, normal voltage is supervised across the live lines. Request Bulletin *906-105. Automatic Switch Co., Florham Park, N. J.*

Copper Clad Laminates . . .

Seven grades or types of Westinghouse Micarta copper-clad laminates for printed circuits can be compared in physical and electrical properties in a new 8-page brochure *B8215* issued by the company. Recommended applications are included for each laminate to guide selection. Included in five paper-base phenolic grades are two new grades having exceptionally high fire resistance and one for applications that are electrically critical. Glass-base epoxy grades are included for applications that are critical in heat resistance and electrical properties, for precious-metal plating, and for applications such as computer cards, which require economy along with high-performance specifications. Write to *Westinghouse Electric Corp. Micarta Div., Hampton, S. C.*

Current Probe Systems . . .

A 2-page specification sheet details characteristics of two systems for observation and measurement of current waveforms. The *P6016* a-c probe and type *131* amplifier constitute a current-detecting system for use with a wide-band oscilloscope. The system provides accurate displays for observation and measurement of current waveforms of low amplitude and fast rise time. Current range is 1 ma to 10 amperes. Pass-band, with a 30-mc oscilloscope, is 50 cps to 17 mc. The *P6016* a-c probe with a passive termination provides for observation and measurement of current waveforms at frequencies to 20 mc (with 30-mc oscilloscope) and sensitivity of either 2 or 10 ma/mv (of oscilloscope sensitivity). For a copy of the sheet write to *Advertisting Depart., Tektronix, Inc., P. O. Box 500, Beaverton, Ore.*

"Fansteel Contacts" . . .

Latest techniques in the use and production of electric contacts and contact assemblies are described in a new technical journal being introduced by the company. The periodical *Fansteel Contacts*, will be published bimonthly and will describe electrical contacts made of tungsten, precious metals, and special alloys. These contacts are used in distributor breaker and voltage regulator points by the automotive industry; in electrical relays, contactor and switch points for military, commercial, and industrial controls; and in high-voltage electrical switchgear. Case histories are included, and plant production methods described, including assembly mechanics and direct-welding, brazing, and sinter-fusion techniques. The publication will be mailed regularly upon request to *Publications Dept., Fansteel Metallurgical Corporation, N. Chicago, Ill.*

Automatic Reset Dial Timer . . .

Bulletin *N-305B* describing the new Series *305B* automatic reset dial timer includes information on construction, installation, application, specialized functions, electrical data and basic circuit arrangements. New 14-point terminal block is a unique feature with cost-saving benefits. Series *305B* timers are used for time control of industrial processes, laboratory and machine automation. For 8-page bulletin write to *Automatic Timing & Controls, Inc., King of Prussia, Pa.*

(Continued from page 22A)

Voice Recorder . . .

Details of the *RA-1651* signal-actuated voice recorder are given in this illustrated 4-page brochure. The magnetic-tape recorder is designed for use where a record of all messages must be kept continuously, such as in police and fire department communication systems. In addition to becoming actuated at the sound of a voice, the unit automatically stamps the time and date directly onto the tape. Operating speed is only $\frac{5}{8}$-inch per second to conserve tape. Copies of Bulletin *3.2* are available from *Westrex Recording Equipment Department, 6601 Romaine St., Hollywood 38, Calif.*

Diffusion Furnaces . . .

A new 4-page bulletin *1081-A* describes in detail gaseous and solid diffusion furnaces as an aid for basic research, pilot-plant studies, and the production of semiconductors. It illustrates and describes eight different units covering the needs of all three fields of interest, and outlines the more mechanical aspects of temperature uniformity, ruggedness of construction and insulation, fast heat-up, ease of installation, and many special features available in these units. Also included in the bulletin are detailed specifications of all thirty-two available units. For a free copy, write the *Semiconductor Div., Lindberg Engineering Co., 2450 W. Hubbard St., Chicago 12, Ill.*

Lens Catalog . . .

The entire line of Wollensak PRO-35 and PRO-70 Raptar Lenses for use on Vidicon TV surveillance cameras, data-recording cameras, radar error measurement cameras, and TV theatrical and documentary cameras are described in this catalog. It covers description, lens diagrams, and specifications for 18 PRO-35 lenses in focal lengths from 1 inch to 30 inches, and 10 PRO-70 lenses in focal lengths from $2\frac{1}{2}$ to 30 inches. In addition there is complete data on TV Raptar lenses for Image Orthicon cameras in focal lengths from 2 to 30 inches and Wollensak Mirrotel lenses in 20-, 40-, 80- and 200-inch focal lengths. Available from *Wollensak Optical Company, Rochester 21, N. Y.*

Glass-Epoxy Laminates . . .

Fireban 600, a flame-retardant glass-base, epoxy-resin laminated plastic, and Fireban 600 E, the copper-clad version, are described respectively in the company's Bulletins *51.5.20* and *51.5.21*. In addition to self-extinguishing properties, the characteristics listed for Fireban 600 include high mechanical strength, high interlaminar bond strength, excellent electrical properties under high-humidity conditions, good chemical resistance and very low moisture absorption. Fireban 600 is supplied in sheets approximately 37 by 49 inches. Minimum or maximum physical and electrical property values are given for sheet stock in thicknesses of $\frac{1}{16}$-, $\frac{1}{8}$-, and $\frac{1}{2}$-inch. Copies of the bulletins are available free on request by writing to *Taylor Fibre Co., Norristown, Pa.*

FM Stereo Components . . .

An experimental kit of filters for FM stereo multiplex radio receivers is described in technical bulletin *6161*. These filters are designed in the standard K-Tran configuration, measuring $\frac{3}{4}$ inch square by $1\frac{7}{32}$ inches. The designs were made possible by the introduction of special high-Q ferrite material developed by the company for use with the patented K-Tran threaded cup core assembly. Built-in capacitors are included in several of the units. Write to *Automatic Manufacturing Div., General Instrument Corp., 65 Gouverneur St., Newark, N. J.*

Pressure Transducers . . .

Norwood bonded strain gage pressure transducers for precision measurement of static and dynamic pressures up to 60,000-psi, are described and illustrated in this technical bulletin 278, which describes briefly the advanced design principle upon which these devices are based, and explains how air-cooled and water-cooled models operate. Supplementary data presented includes a typical performance specifications table; a data sheet selection chart covering 14 basic models, with maximum pressure limits for each, variety of strain gage bridge designs, and of threads, available; a table of cable and connector assemblies; and a list of mating connectors. Write to the *American-Standard Controls Div., 5900 Trumbull Ave., Detroit 8, Mich.*

120-Mc Aircraft AM Transmitter . . .

This report describes a transistorized 120-mc aircraft AM transmitter utilizing the Motorola *2N1692* and *2N700* amplifier mesa transistors. The paper, titled "Special Report Number 34," discusses power specifications in AM transmitters, alignment of AM transmitters, as well as circuit description and performance of a 120-mc AM transmitter. Copies of the report may be obtained by writing to the *Technical Information Center, Motorola Semiconductor Products Inc., 5005 E. McDowell Rd., Phoenix 8, Ariz.*

(Continued on page 24A)

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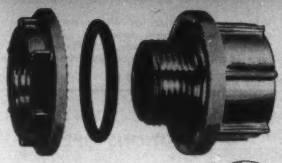

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Regular classified advertisements set solid—no display—minimum 5 lines: $3.00 per line. No agency commission or cash discount allowed. Situation Wanted classified advertising for AIEE members: $2.00 per line, minimum 5 lines. Address orders to: Classified Section, ELECTRICAL ENGINEERING, 6th Floor, 33 West 39th Street, New York 18, N. Y.

When answering an advertisement, send all replies to box number specified, c/o ELECTRICAL ENGINEERING, 6th Floor, 33 West 39th Street, New York 18, N. Y., unless other address is given.

POSITIONS OPEN

PROFESSORS, all levels. Ph.D. required. Solid-state, electromagnetics, and engineering analysis especially. Income, with research, competitive with industry. Graduate program as large as undergraduate. Mile-high, dry climate. Chairman, Electrical Engineering Department, University of New Mexico, Albuquerque, New Mexico.

INSTRUCTORS, Associates, Assistants for teaching and research part-time position while working for M.S. and D.Sc. Large graduate program assures variety of offerings. Chairman, Electrical Engineering Department, University of New Mexico, Albuquerque, New Mexico.

RESEARCH ENGINEER for applied research work on basic approaches to small electric motors. Background required in Electromagnetics. Salary $7,000 to $9,000. Send resume to Personnel Manager, Black and Decker Mfg. Co., Towson 4, Maryland.

ELECTRICAL ENGINEERS—with degree and 10 to 15 years experience in design and supervision of all phases of utility engineering required for position in near east. Salary open. Housing and transportation furnished with other Company benefits. All replys held confidential. Send complete resume of qualifications and personal information to: Miner and Miner International, Inc., P. O. Box 748, Greeley, Colorado.

DEPARTMENT HEAD. Head professor for 12-man E. E. department. Excellent opportunity for energetic and progressive Ph.D. with experience and potential to build, administer, and participate in a balanced program of teaching, research, and extension. Box 145.

ELECTRICAL ENGINEER. Central Illinois utility has opening in substation design, transmission design and communications for engineer with a degree. Previous experience in these fields desirable. Salary up to $9,000. Send resume of education and experience to Box 146.

CONTRACT WORK WANTED: Plastics Compression Molder desires contract work. Good opportunity if you can use our facilities. Good labor. Modern Plant Located vicinity New York City. Write Box No. 148.

SALES ENGINEERS. Philadelphia and other Eastern locations. Positions available for Engineers to sell Industrial Motor Control. Salary plus incentive compensation. Replies treated confidentially. Submit resume to: D. J. Cassidy, THE CLARK CONTROLLER COMPANY, 1146 East 152nd Street, Cleveland 10, Ohio.

UTILITY ELECTRICAL ENGINEER—for administrative headquarters of nationwide utility; must have E. E. degree, preferably with an additional business or advanced engineering degree. A minimum of 8 years of engineering, operating and administrative experience is required. Age 30-45. Salary open. Send resume of background and qualifications to: B. D. Browne, Citizens Utilities Company, Ridgeway Center, Stamford, Connecticut.

ELECTRICAL ENGINEER. Recent graduate to ten years experience. Research and development work in electrical appliances—vacuum cleaners, floor polishers, washing machines, irons, etc. Growth company with factories around the world. Position open in headquarter's Engineering Division in Northern Ohio. Excellent opportunity for solid engineer with management potential. Send resume to: S. G. Shirk, The Hoover Company, North Canton 20, Ohio.

ELECTRICAL ENGINEER-TRAINEE. Wanted by leading non-ferrous metal producer for work in Western Montana. Send resume to V. J. Kyllingstad, Personnel Dept., Employment Division, The Anaconda Co., Butte, Mont.

POSITIONS WANTED

MOTOR ENGINEER—Age 40. Substantial small motor development, design, administrative, and auxiliary engineering operation supervisory experience with one large manufacturer. Ready for move into product engineering supervision. Location immaterial. Current salary $15,500. Box 147.

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Be sure to address all Personnel Service box numbers to Box _____

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Symposium on Research and Education

Special Publication S-82 comprises of four papers that were presented at the AIEE Winter General Meeting, New York, N. Y., February 2, 1956, and is sponsored by the AIEE Committee on Research and Education. The papers deal mainly with the problems of the utilities and the industry in general in attracting young engineers into the field.

The price is $1.60 ($0.80 to AIEE members). Available from:

Order Department

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

33 West 39th Street
New York 18, N. Y.

Safety Tach . . .

A new bulletin describes Dayton safety tach, the completely portable self-contained photoelectric tachometer for fast, accurate speed measurement of both rotating and reciprocating machinery. Entirely self-contained, it requires no external power source and no mechanical or electrical contact with the machinery whose speed is being checked. Unlike a stroboscopic tachometer the instrument will measure the speed of both constant and changing speed machinery. The bulletin includes specifications on the three standard safety tach models covering speed ranges from less than 100 to 24,000 rpm. For a free copy, write to *Simonds Worden White Co., 1101 Negley Place, Dayton 7, Ohio.*

Distortion Analyzer Filter . . .

The new Ortho distortion analyzer filter, for the measurement of the total harmonic content of an a-c signal, is described in the company's technical data page. Designated "Series DA," it was designed to act as a passive device, permitting the measurement of total rms harmonic distortion of a specific fundamental frequency. The measurement can be effected by any standard high-impedance vacuum-tube voltmeter with a flat frequency response to the tenth harmonic of the fundamental measured. The data include a curve that plots the frequency response; another shows the relationship between the decibel level of distortion components and the per cent of distortion. A table of specifications is also included. Copies of this literature will be supplied by *Ortho Filter Corporation, Subsidiary of Ortho Industries Inc., 7 Paterson St., Paterson 1, N. J.*

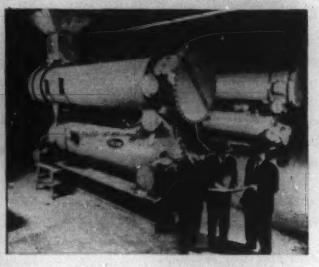
Glass-Bonded Mica . . .

Literature giving new, detailed information on MYKROY glass-bonded mica as a high-frequency insulator presents data assembled in extensive tests on MYKROY 750 and MYKROY 1100, which conform to MIL-I-10A-L443 and MIL-I-10A-L442 respectively. The tests established the two grades as excellent low-loss insulators at high frequencies. High-frequency capacitance coupling devices made of copper and gold-plated MYKROY 1100 are now in production at EMI. In addition, the company will use both MYKROY 1100 and MYKROY 750 for production of high-frequency switch mechanisms, commutators, microwave insulation, and feed-through and stand-off insulation. Data on MYKROY glass-bonded mica is available from *Electronic Mechanics, Inc., 101 Clifton Blvd., Clifton, N. J.*

Industrial Notes...

Carrier Corp.
Syracuse, N. Y. . .

Installation of one of the world's largest heat pump systems, which will use heat generated by people, lights, and business machines to warm office areas, was begun recently in the Allen-Bradley Company's new $15 million headquarters and research center in Milwaukee, Wis. The record heat pump system consists of three large-



capacity electrically powered refrigerating machines each weighing about 20 tons. Built by Carrier Air Conditioning Company, the machines will be used in summer to provide chilled water for cooling the 8-story structure, and in winter, the same machines will remove excess heat from interior spaces so it can be used to warm areas next to outside walls. No boilers or other fuel-burning devices are required.

Datex Corp.
Monrovia, Calif. . .

A digital recording and control system that will speed X-ray diffractometer operations in basic research on structure of matter is being designed by the Datex Corporation. The equipment will be divided functionally into a position control system and a data recording system. The control part will extract data from punched paper tape and, utilizing this data, control the position of a crystal with respect to a radiation source and control the position of a counter read head which measures the radiation diffracted by the crystal. The data recording portion of the system will record the positions of the crystal and counter read head as well as radiation counts accumulated by the counter. The position data will be automatically extracted from the input tape, and position and recording commands will be automatically generated.

Royal McBee Corp.
Port Chester, N. Y. . .

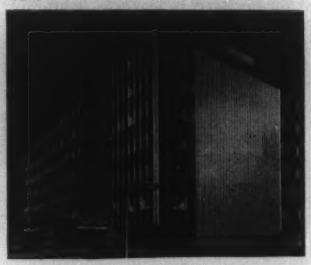
A significant new technique in electronic computer marketing is about to be launched in an aggressive campaign by Royal McBee Corporation who is taking the otherwise stationary electronic computer on the road. The company has constructed four giant "Computerama" trailers that house electronic computer equipment in an attractive office setting. The tractor-pulled, 50-foot-long Computeramas will travel some 100,000 miles this year to carry demonstrations of the Royal Precision computers to customers throughout the U.S.

Allis-Chalmers Mfg. Co.
Milwaukee, Wis. . .

A 370-mva, 138-kv main generator transformer for Unit 3 at the North Lake Steam Electric Station of Dallas Power & Light Company will be supplied by Allis-Chalmers. When Unit 3 is placed in service, it will be the largest generating unit on the utility's system west of the Mississippi River. The company will also furnish six 138-kv, 10,000-mva oil circuit breakers and other auxiliaries for this station extension.

Eastman Kodak
Rochester, N. Y. . .

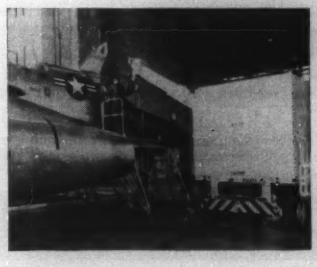
The new, modern 7-story physics research building of the Eastman Kodak Company in Rochester, N.Y., contains over 200,000 square feet of floor space and accommodates a staff of 400 members. There are over 200 special rooms where research will be



carried on in such fields as theory of the photographic process, image structure, optical systems, sensitometry, radiography, sound recording, electrostatics, and solid-state physics.

Sperry Gyroscope Co.
Great Neck, N. Y. . .

Hour-to-hour combat readiness of the Strategic Air Command's B-58 Hustler supersonic jet bombers soon will be greatly improved by an advanced checkout system now completing final Air Force evaluation. Aerospace Ground Equipment (AGE) will allegedly provide mission-to-mission assurance of the pinpoint accuracy and reliability



of the B-58's precise bombing-navigation system. Sperry Gyroscope Co. designed and produced the ground support equipment which can make one automatic measurement every 4 seconds, and a complete bombing-navigation checkout in only a few hours. The support equipment's miles of punched tape will direct a primary trial of the system. As many as 3,600 "go-no-go" visual presentations flash the alert on any malfunction.

Jerrold Electronics Corp.
Philadelphia, Pa. . .

Jerrold Electronics Corporation announces its entry into the microwave equipment field. The company's new equipment, available in the 6-kmc band, will be able to handle 600-line wide-band video for closed circuit or community antenna systems, as well as extremely high rates for computer "talk" for data systems. Features include: wide-base-band frequency response covering 30 cps to 8.0 mc, flat within 0.25 db; high-frequency stability, holding an assigned frequency within 0.005%; 1-watt output; multiple-channel input and output mixing, provided for on one antenna; a circuit monitoring arrangement, which monitors modulation deviation and output frequency, and permits all tubes or circuits to be checked from the front panel.

Gibson Atomiclad* Electrical Contact Rivets now available in economical Gibson Assemblies

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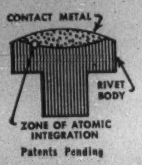


And they're BETTER because their bond of dispersed atoms of the precious contact metal and the base metal of the body is electrically and mechanically superior to other bonding methods. Cost is further reduced by limiting use of precious metal to electrical requirements of the contact.

Atomiclad Rivets are made in all standard forms and of copper, steel or other base metal with contact face of precious or semi-precious metals.

Many sizes and types are stocked in quantity. Write for Standard Stock List #2007, and for Technical Information Bulletin 400.

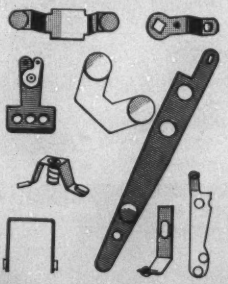
ECONOMICAL GIBSON CONTACT ASSEMBLIES

Gibson contact support manufacturing facilities include every phase—forming, riveting, heat-treatment and electroplating and comprises use of any specified metal.

When you specify Gibson Contact Assemblies, you get the benefit of years of engineering know-how in providing the best possible electrical union between contact and support member. Since all assemblies are Gibson-inspected, the customer suffers no loss through assembly rejects.

Gibson Engineers will design your complete contact assembly upon receipt of specifications. Or send your drawings for fabrication costs. If you prefer your own support member, send a sample for assembly cost.

*ATOMICLAD—Trademark Gibson Electric Company



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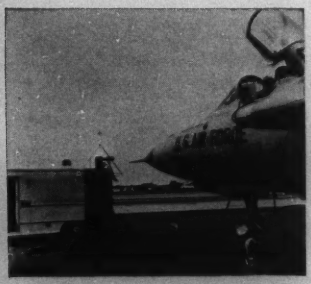
(Continued from page 27A)

Remanco, Inc.
Santa Monica, Calif. . .

A "flightline" radar testing system that checks an aircraft's radar in all of its various modes, air-to-air, air-to-ground, terrain avoidance, and others, in a fraction of the time previously required has been developed by Remanco, Inc. The *RTS-103* test unit, used to check out in-flight performances of air-borne radar units built into the Air Force's supersonic *F-105* fighter bomber, has been called a "confidence checkout" because it enables an over-all systems test to be performed on the ramp immediately prior to flight.



General Electric
Schenectady, N. Y. . .

A $1 million order for main power supply electric equipment on the world's most powerful magnet has been received by the General Electric Company. The order was placed by Massachusetts Institute of Technology, Cambridge, Mass., under a $6 million contract with the U.S. Air Force's Office of Scientific Research for the construction and operation of a new research laboratory. Created as a research center for the study of magnetic fields, the MIT National Magnet Laboratory is expected to make possible the discovery of new knowledge about the properties and behavior of atoms, atomic particles, and aggregations of atoms in solid materials, liquids, and gases. Groups from academic, government, and industrial research institutions in the United States, and visiting scientists from other nations, are expected to use the installation.

Burndy Corp.
Norwalk, Conn. . .

Burndy Corporation, Norwalk, Conn. and Glass-Tite Industries, Inc., Providence, R. I. have just announced an agreement by which Burndy will acquire a 50% interest in Escon, Inc., subsidiary of Glass-Tite. As a result of the cash transaction, the Escon operation will be renamed Burndy-Escon, Inc. Burndy and Glass-Tite will have equal representation on the new board of directors. Escon has made outstanding progress in the design and application of glass and ceramics to electrical connectors for high-temperature requirements. Burndy, with its vast engineering and marketing resources to contribute to the joint venture, will market the products of Burndy-Escon.

Rochester Instrument Systems, Inc.
Rochester, N.Y. . .

A new corporation, Rochester Instrument Systems, Inc., will design and manufacture electronic instruments and systems for the process control industry, with emphasis on nuclear reactor instrumentation. Electronic medical instruments are also under development, and a standard line of annunciators, electronic trips, and signal converters are under way.

Gulton Industries
Metuchen, N.J. . .

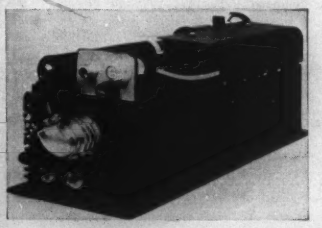
A system of automatic telemetry magnetic tape editing, developed cooperatively by Gulton Industries and the General Electric Company's Missile and Space Vehicle Department, simplifies the task of editing the large volumes of telemetry data recorded on magnetic tape during over-the-ocean missile tests. The machine performs both switched and continuous editing, and eliminates redundancy from large quantities of telemetry information almost as rapidly as data are collected from receiving stations strung out along the missile range. Automatic searching of all data reduces the chance of overlooking unsuspected phenomena. The machine also measures telemetry system information previously considered unimportant but which might further improve editing techniques.

(Continued on page 29A)

(Continued from page 28A)

Lockheed Electronics Co.
Plainfield, N.J. . .

A new active radar augmenter has been developed by the company for use in electronically simulating the radar echo characteristics of small, medium and large target vehicles. The



augmenter is intended for installation in drone or target aircraft to reinforce radar tracking facilities in missile-carrying aircraft. The unit receives the radar-transmitted signal and transmits an amplified signal back to the aircraft. It thus enables a target of small size to appear as a large radar presentation, since the radar echo is essentially enhanced as a result of the power gain characteristics of the traveling wave tube amplifier.

Collins Radio Company
Dallas, Texas . . .

The several divisions of the Collins Radio Company, including its systems management subsidiary, Alpha Corporation, are providing communications, range instrumentation, and data-handling facilities at Pacific missile range activities in continental United States, down-range, on range instrumentation ships, aircraft and in mobile range equipment. Largest is an instrumentation data transmission system, which interconnects Point Mugu, San Nicolas Island; the Naval Missile Facility, Point Arguello; and Vandenberg Air Force Base by way of Santa Cruz Island. The system, which uses microwave as a transmission medium, is the most complex of its type ever installed. It handles voice and teletype communications for range control, timing and telemetry data, precision radar tracking data, and radar surveillance information, and provides for the remote control of missiles, drones and aircraft. It permits any of the three major Pacific missile range activities in this area to function as a primary control center, with inputs to that center from all other sites.

(Continued on page 31A)

NEW BIDDLE INSTRUMENTS Products

Conductor Phase Identification Set Saves Labor Costs

on Phase Determination and Conductor Identification on Underground Cable Systems

The Biddle Conductor Phase Identification Set employs a unique circuit that provides positive and reliable identification *without the need for removing all safety grounds.* Transmitter can be operated from either 60-cycle supply or self-contained dry cells. The detector is similar to a clamp-on ammeter. When clamped around A phase conductor, the pointer deflects left; when clamped around B phase conductor, it deflects right; when clamped around C phase, there is no deflection. Pick-up coil and earphone unit is used with transmitter to identify the cable itself. This means of positive cable identification results in safer operations and reduced labor costs.

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Complete set includes transmitter, phasing detector and cable identification detector.

Biddle-Balsbaugh Test Cell Kit for Liquids

This kit is used with a Megger insulation resistance tester to make resistivity measurements of insulating oils and other liquids. Useable at test voltages up to 5,000 volts d-c. For complete details—

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another publication

Third Report on Survey of Electric Utility Applications of Digital Computers

This listing and description of electric utility applications of digital computers is a revision of AIEE Special Publication S-109. Included are solicited contributions from privately owned and publicly owned utility systems having more than 75,000 custom meters.

Presented at the AIEE Winter General Meeting, New York, N.Y., January 29—February 3, 1961.

Prepared by AIEE Computer Application Subcommittee of the AIEE System Engineering Committee.

Send $2.50 for S-109-A to

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(Continued from page 29A)

General Testing Laboratories
Moonachie, N. J. . .

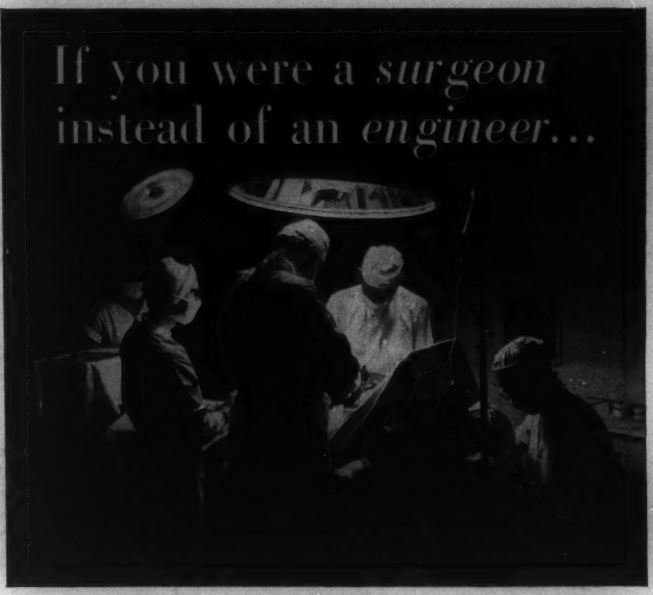
Announcement was made recently by General Testing Laboratories of the company's affiliation with Thompson Ramo Wooldridge, Inc. The affiliation was effected to enable both companies to broaden the scope of their testing work and facilities. Projects currently in progress include work in the Titan and Minuteman missiles, B-58 and B-70 Air Vehicle programs. The Tapco-Roanoke division of Thompson Ramo Wooldridge, Inc. is equipped to operate in conjunction with General Testing Laboratories' facilities for hazardous testing. Together, both laboratories can now provide up-to-date extreme environmental conditions for the testing and evaluation of electrical, electromechanical, mechanical, pneumatic and hydraulic components and systems involving masses up to 1,000 pounds.

Gorham Electronics
New York, N.Y. . .

A contract calling for production of 20 *L* band circular linear polarization units for Raytheon Company has been awarded to Gorham Electronics, subsidiary of Gorham Corporation. The Polarizer, a key component of the system, will help track commercial aircraft between major airports. Dependable operation is assured in rain and other bad weather because these new radar systems permit either linear or circular polarization of the radar signal, depending upon weather conditions. Linear polarized radar is often unable to "see" targets through storm clouds since both target and clouds reflect the radar beam. To eliminate this handicap, circular polarization can be applied to the outgoing beam. This assures all weather operation and is effective up to a radius of 200 miles.

Space Electronics Corp.
Glendale, Calif. . .

Under a $100,000 contract with the U. S. Naval Ordnance Test Station, Space Electronics Corporation will manufacture five dual-channel phase-lock receivers as part of the space tracking and telemetry system for the transit navigational satellite program. The units will provide high sensitivities, ranging from −160 to −164 dbm and will operate at discrete frequencies over a frequency band in the vhf and uhf regions. Modular construction, permitting wide versatility, will be employed in building the receivers. The equipments will be completely transistorized.



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